The Wisconsin Voluntary Emission Reduction Registry

How To Make It Work for You

WISCONSIN
DEPT. OF NATURAL RESOURCES

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WISCONSIN VOLUNTARY
EMISSION REDUCTION
REGISTRY

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For more information on the material in this document, please visit the Voluntary Emission Reduction Registry web site at http://www.dnr.state.wi.us/org/aw/air/registry/ or call the DNR Bureau of Air Management at 608-266-7718.

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I.

I. What is the Wisconsin Voluntary Emission Reduction Registry?

The Wisconsin Voluntary Emission Reduction Registry is a registry of voluntary reductions of greenhouse gas and air contaminant emissions which result from actions taken by businesses, governments, organizations, individuals, or others to reduce emissions. The reductions are voluntary, either because they are not required by law or go beyond legal requirements.

The registry exists primarily as a database listing the registered emission reductions. The Registry Program includes rules (Chapter NR 437, Wis. Adm. Code, see Appendix C), application forms, and lists of quantification protocols. All registry components are contained on the registry web page at http://www.dnr.state.wi.us/org/aw/air/registry/.

Registering voluntary emission reductions will be relatively simple in some cases, but may be very complicated in others. A number of decisions must be made before registering reductions, including how to determine the baseline, how to quantify emission reductions, whether and how to verify emission reductions, how the voluntary emission reductions may be used, and what records need to be kept. The emission reduction registry rule answers some of these questions very specifically. However, it doesn't necessarily provide information on all possible options. The purpose of this document is to provide information and help registrants choose the best options for them.

II. Background and History – Where Did the Registry Come From?

The Wisconsin Climate Change Action Plan was published by the Department in 1998 (AM271-98, May 1998). One of the recommendations in the action plan is that Wisconsin develop a system to provide credit to those who reduce greenhouse gas emissions early. The DNR and Wisconsin's Environmental Decade worked with state legislators to draft and sponsor 1999 Wisconsin Act 195, the voluntary emission reduction registry bill. Wisconsin Act 195 was signed into law on May 17, 2000, and went into effect on June 1, 2000; the bill created section 285.78 of the Wisconsin Statutes.

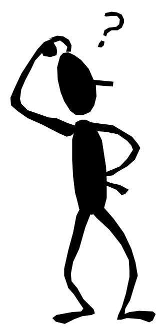
The law directs the Department to "establish and operate a system under which the department registers reductions in emissions of greenhouse gases if the reductions are made before the reductions are required by law." The law allows the Department to register carbon sequestration from the creation or preservation of carbon reserves and to register avoided emissions resulting from energy efficiency measures and from the use of renewable energy sources. The law also allows the Department to register voluntary reductions of mercury, fine particulate matter or other air contaminants. The law allows the registration of greenhouse gas emission reductions as far back as 1991. And finally, the law directs the Department to promulgate rules for the registry system.

In 2002, the Department created a new regulation (chapter NR 437, Wis. Adm. Code, Voluntary Emission Reduction Registry, see Appendix C), which specifies the details of how the registry will operate. Section V of this document discusses that regulation (see page 11).

III. Should I Register? (or What's in it for Me?)

A. Why would I voluntarily reduce my air emissions?

Many companies around the world have made pledges to reduce greenhouse gas emissions, including a large number of multi-national corporations. They also include the more than 70 smaller companies in Wisconsin which have pledged to reduce greenhouse gas emissions through the adoption of energy efficiency measures. So, why are these companies reducing greenhouse gas emissions when they are not yet required to do so? And, even more importantly, why would you want to reduce your air emissions?



There are many reasons to voluntarily reduce greenhouse gas and air contaminant emissions. Taking action now can:

- Increase efficiency and save money

  When you adopt energy efficiency measures to reduce greenhouse gas and air contaminant emissions, you may improve efficiency and use less energy. By using less energy, you generally (but not always) save money.

- Improve profitability and increase competitiveness

  By increasing efficiency, your product or service can be produced or provided at a lower cost with less energy input. This could increase your profitability and may make your company more competitive.

- Get ahead of the curve

  For greenhouse gases and some air contaminants (mercury and fine particulate matter), regulations which will require emission reductions are likely. By reducing your emissions early, you can prepare yourself for the future and get ahead of the crowd. This will give you good experience and can give you a competitive advantage.

B. Why should I register my emission reductions?

If you choose to reduce emissions voluntarily, then it is probably in your best interest to register your emission reductions. There are a number of good reasons to register, which are listed and discussed below.

1. Baseline Protection

The main reason to register your voluntary emission reduction is to protect yourself. Unfortunately, if you reduce emissions early, you may not get credit if future regulations require you to reduce emissions and those regulations don't recognize the emission reductions you've already made. This has happened in the past, and is one of the main reasons why the DNR is operating the emission reduction registry. If your voluntary emission reduction is registered with the state, it is more likely to be recognized and taken into account later when regulations requiring those emission reductions go into effect. We can't guarantee that your reduction will count towards future requirements (especially federal requirements), but we will do our utmost to ensure that your voluntary early emission reduction is recognized and counted under any future state or federal laws.

2. Public Recognition

A second reason to register emission reductions is to receive public recognition of your actions. Under the Wisconsin Voluntary Emission Reduction Registry, your good deed will be displayed on the registry web site for everyone to see. The Department may also publicize emission reduction actions in other ways (press releases, brochures, awards). This recognition can count for a lot, especially as people direct their business towards green companies.

3. Central Listing of Emission Reduction Purchase Opportunities

Another reason to register is to draw market attention to your reductions. Some emission reductions may be marketable as offsets for those who want to increase emissions in ozone non-attainment areas (if you are located in a non-attainment area). There is also a developing market for greenhouse gas emissions. We expect that people wishing to purchase emission reductions will use the registry to locate emission reductions. Please remember that when a registered emission reduction is sold or used to meet an emission offset requirement, it can no longer be registered as a voluntary reduction.

You must be careful in selling or buying emission reductions. In the U.S., markets with clear rules have been established for some air contaminants, notably sulfur dioxide (SO_2). The sulfur dioxide allowance trading market is well established in the U.S. under rules carefully spelled out in federal laws and regulations. The SO_2 market has been very successful and has significantly lowered the costs of reducing SO_2 emissions in the U.S. compared to traditional command and control regulations. Limited trading of nitrogen oxide (NO_x) and volatile organic compound (VOC) emission reductions is allowed in some parts of the country (e.g., New England and California), and NO_x trading will soon be allowed nationwide.

However, for gases or air contaminants which have no established emission reduction trading markets or trading rules, you trade at your own risk. Currently, the main example of this is greenhouse gas emissions, where no uniform trading rules have been established. Fledgling markets are developing, and a limited number of private trades have occurred. In the future, a greenhouse gas cap and trade system may require you to reduce your greenhouse gas emissions. If you sell your early emission reduction, you may be required to further reduce emissions in the future. You may want to keep your emission reduction in the registry for future use.

Also, if you do sell your early emission reduction, you will likely be required by the buyer to hire an impartial third party to verify the emission reduction. Thus, if your primary reason for registering voluntary emission reductions is to sell the emission reductions, it would benefit you to have them verified by a third party before registering (see the verification discussion on page 24).

C. Limitations of the Registry

Despite the benefits of registering emission reductions, there are a number of limitations to the registry.

First, it does not guarantee baseline protection. The Department cannot guarantee that any registered emission reduction will be recognized or taken into account by any future laws or regulations (especially federal laws and regulations). However, we will do our utmost to ensure that your voluntary early emission reduction is recognized and counted under any future state or federal laws. If your voluntary emission reduction is registered with the state, it is more likely to be recognized and taken into account when regulations requiring those emission reductions go into effect.

Secondly, there will be minimal review of emission reductions by Department staff and no official Department stamp of approval. Thus, the registry does not guarantee the quality or veracity of registered emission reductions. If you are able to use your registered reductions in the future, those reductions may not meet the requirements of laws in the future. The registry also does not fulfill the regulatory requirements for credit under the State Implementation Plan and other existing regulatory programs, including offset programs in non-attainment areas. Additional work may be necessary to verify the emission reductions and bring them up to the standards required by other programs or regulations.

IV. What Types of Emission Reductions May Be Registered?

In this section, broad categories of emission reduction actions are discussed to clarify the types of possible emission reductions which can be registered. This is not a complete list of possible emission reduction actions. We encourage you to use your imagination and creativity to develop innovative emission reduction projects. Examples of many of these actions are provided in Appendix B.

A. Direct Emission Reductions

Direct emissions are emitted from a source or process that is owned or operated by the person responsible for the emissions. The owner or operator has control of the emission source. Examples of direct emissions are smokestack emissions from an industrial facility and tailpipe emissions from your car. Both of these are discussed below.

1. Stationary Sources

Stationary sources are sources which don't move while emitting air pollutants. Industrial plants, homes, landfills, and shopping malls are all stationary sources. There are many actions which can be taken to reduce stationary source emissions. These include fuel switching, process changes, installation of emission control equipment, improvements in combustion efficiency, and product reformulation.

2. Mobile Sources

As the name implies, mobile sources are sources which emit air contaminants while they are moving. These are primarily in the transportation sector (cars, trains, planes, and buses), but snowmobiles, motorboats, construction equipment, and lawnmowers are also mobile sources. Due to large numbers and increasing use, the automobile is the major mobile source of air contaminant emissions. Air pollution control programs have focused on automobiles, but trains, planes, buses, SUVs, minivans, heavy-duty trucks, pickup trucks, and motorcycles are also being considered for additional regulation.

Actions which can be taken to reduce emissions from the transportation sector fall into two main categories:

a) Actions Which Reduce Vehicle Miles Traveled

For the transportation sector, reduction in vehicle miles traveled (VMT) could come from a broad range of activities, including trip reduction through

- teleconferencing or video conferencing
- telecommuting, flexible work schedules, and compressed work week schedules
- transportation modal shifts (e.g., personal vehicle to transit, bike to work programs, walking)
- carpooling and van pooling programs
- other transportation demand management (TDM) efforts.

Other categories of actions include traffic management, control measures (e.g., ramp metering, high occupancy vehicle carpool lanes) to reduce congestion and transportation, and land-use integration aimed at trip reduction. These efforts have historically been aimed at ozone reduction but they also have positive implications for greenhouse gas emissions reduction.

Unfortunately, emission reductions from these types of activities tend to be difficult to quantify. Quantification usually involves making assumptions and/or using survey results. These complications will make it difficult to register accurate emission reductions from VMT reduction projects.

b) Actions Which Reduce Emissions per Vehicle Mile Traveled

Actions which reduce vehicle emissions include use of alternative fuels (propane, ethanol, methanol, hydrogen), alternative vehicle technologies (electric vehicles, hybrid vehicles, fuel cell vehicles), and more efficient tailpipe exhaust controls on conventional gasoline powered vehicles. These actions are typically easier to measure and registering these reductions is a straightforward process. This type of reduction would not be difficult for fleet operators (private fleets, government fleets, transit fleets, delivery fleets, etc.). For example, if the owner of a large fleet of delivery trucks switched all of its trucks from diesel to propane or another alternative fuel, it would be relatively simple to track the miles traveled and determine the emission reductions.

B. Indirect Emission Reductions

Indirect emissions come from a source that is not owned or operated by the person responsible for the emissions. The best example of indirect emissions is the use of electricity from the grid. Whenever we use electricity from the grid, air contaminants are emitted at the power plant where the electricity is generated. End-use energy efficiency measures help to reduce or avoid indirect emissions. Renewable energy projects can also reduce electric utility emissions.

C. Carbon Sequestration

Carbon sequestration is the establishment or enhancement of a carbon reserve. A carbon reserve is any system that takes in and stores more carbon from the atmosphere than it releases to the atmosphere [see the definitions in s. NR 437.02(3) and (4), Wis. Adm. Code.]. A forest or a prairie or other terrestrial ecosystem is a carbon reserve. Carbon sequestration projects typically involve planting or protecting forests, but other projects are possible. Sinking carbon dioxide collected from a power plant smokestack into the ocean is a form of carbon sequestration, assuming the carbon dioxide remains where it is put and doesn't find its way back into the atmosphere.

D. Aggregated Emission Reductions

As noted in the registry rule [s. NR 437.03(5)(d), Wis. Adm. Code.], emission reductions may be aggregated from several or many sources to exceed the registration thresholds in Table 1 (See Appendix C). Aggregation of emission reductions could take many forms. For example, hybrid or electric car owners in Milwaukee County could band together and aggregate their emission reductions. An appliance dealer could develop and sell a more efficient appliance and aggregate the indirect emission reductions from the use of these appliances in Wisconsin. People doing prairie restorations could band together to register the carbon sequestered in their Wisconsin prairie restorations. Or a residential energy efficiency consultant could aggregate the energy savings from all of his projects during the past year. The possibilities for aggregation are limited only by the bounds of our collective imaginations.

The major difficulty with aggregated emission reductions is determining ownership of the emission reduction. Who has the "right" to register these reductions? This needs to be agreed upon and clearly understood before the reduction can be registered, preferably through a contract or other agreement.

Probably the simplest emission aggregation is the situation where the person claiming the reduction is in a position to arrange for aggregation. For example an appliance manufacturer who builds and sells high efficiency appliances could claim the aggregated emission reduction from all the appliances sold in Wisconsin. The manufacturer could do this through a rebate program where he or she essentially buys the rights to any reduced emissions by providing a rebate to those customers who sign an agreement to give the manufacturer the rights to the emission reductions. This would constitute a legal agreement between the company and the customer, making it very clear who owns and may register any reduced emissions. It may also be necessary for the customer to certify that the old appliance is no longer used, to ensure that the reduction actually occurs.

The customer always has the right to not sign the agreement and not take the rebate, if he or she wants to register the emission reduction. However, most people would have no interest in trying to register the emission reduction from the purchase of one appliance, unless they were doing several other things to significantly reduce their emissions. Automobile manufacturers could also do this, if they produce and sell enough low emission vehicles in Wisconsin. See Example 2 in Appendix B for a more detailed description of this type of aggregated emission reduction.

In the examples given above, the responsible official who would certify the emission reduction would be an employee of the appliance company or automobile manufacturer. Determining the responsible official for aggregated emission reductions would be more difficult in other situations. If the hybrid and electric car owners in Milwaukee County wanted to band together and claim the aggregated emission reductions from their cars, they would have to form some sort of organization and designate a person in the organization to be the responsible official.

V. How Do I Use the Emission Reduction Registry?

The registry is designed to be simple and easy to use, once you know the rules. The rules are contained in Chapter NR 437, Wis. Adm. Code, (see Appendix C). In the following sections, we explain and discuss the rules and how to document and register emission reductions.

A. Eligibility

You need to determine whether your emission reduction, avoided emissions, or carbon sequestration project is eligible to be registered. Eligibility is spelled out in the rule and explained below.

1. Which Air Contaminants are Eligible?

Voluntary reductions of all greenhouse gases, most criteria air pollutants, and mercury are eligible to be registered. Criteria pollutants are the six traditionally regulated air pollutants: sulfur dioxide, nitrogen oxides, particulate matter, carbon monoxide, ozone, and lead. For more information on criteria pollutants visit http://www.epa.gov/air/urbanair/6poll.html. The only criteria pollutant not eligible for registration is ozone, because it is not emitted directly into the air. Rather, it is formed in the atmosphere from the reactions of nitrogen oxides and volatile organic compounds (VOCs), which are emitted directly into the air. Nitrogen oxide and VOC emission reductions are eligible to be registered. Reductions of most toxic and hazardous air contaminants are not eligible to be registered (mercury and lead are the only exceptions).

The eligible air contaminants are listed in Table 1 in NR 437 (see Appendix C) along with the registration threshold for each gas. In order to be registered, the voluntary emission reduction must be equal to or greater than the threshold level in Table 1 for the greenhouse gas or air contaminant being reduced. Note that emission reductions may be aggregated from several or many emission reduction projects in order to meet or exceed the registration threshold given in Table 1 [NR 437.03(5)(d)]. See page 10 for a discussion of aggregated emission reductions.

Mercury collected through a mercury collection and disposal project may be registered if the mass of mercury collected is equal to or greater than ten pounds [NR 437.03(5)(e)]. The amount of mercury collected does not need to be translated into an air emission reduction. [NR 437.06(6)] All greenhouse gas reductions are reported as carbon dioxide equivalents, so reductions in greenhouse gas (GHG) emissions are always lumped together. [NR 437.06(2)]

Some emission reduction actions result in reductions of multiple air contaminants and/or greenhouse gases. In this case, if the reduction of any one of the air contaminants or greenhouse gases equals or exceeds its registration threshold level, then all of the reductions may be registered. [NR 437.03(5)(c)] This is the only exception to the registration threshold requirement.

For example, suppose you operate a small manufacturing facility and you heat it by burning coal in a small boiler to heat water for radiators. You replace this system with a natural gas fired furnace and a forced air heating system. By doing this, you will likely reduce your carbon dioxide emissions by more than 25 tons per year, which is the registration threshold for greenhouse gases in Table 1 in NR 437. However, this action may not reduce your SO_2, NO_x, particulate, or other emissions enough to get them over their respective registration thresholds. Since the greenhouse gas emissions have been reduced by more than the GHG registration threshold, you may register the reductions for all of the pollutants reduced, even though most of the reductions are below their registration threshold values.

2. Who May Register an Emission Reduction?

Any person may register a voluntary emission reduction. Person is broadly defined in s. NR 400.02(123), Wis. Adm. Code and includes individuals, corporations, companies, cooperatives, partnerships, associations, public or private institutions, municipalities, government agencies and others. Basically, a very broad group is eligible to register voluntary emission reductions.

3. What Emission Reductions are Eligible to be Registered?

Most voluntary emission reductions are eligible to be registered if the substance reduced is listed in Table 1 in the registry rule and the reduction exceeds the registration threshold listed in Table 1 for that substance. However, there are some additional eligibility requirements for emission reductions. These requirements are discussed below.

a) The emission reduction must be voluntary and not required by law.

Law is defined in the registry rule-to mean “any federal or state statute, rule, order, mandatory emission limiting condition in an air permit or other legal requirement.” A voluntary emission reduction may also be registered if it goes beyond what is required by law.

From an emission reduction requirement standpoint, there are two types of voluntary emission reductions: those which have no existing emission reduction requirements and those which do have existing emission reduction or emission control requirements. For example, there are currently no laws in existence requiring greenhouse gas emission reductions. Thus, any reductions of greenhouse gas emissions are considered to be voluntary and eligible for registration, as long as the reductions meet all the requirements of NR 437. For most of the other air contaminants listed in the registry rule, there are laws in existence requiring emission reductions or specifying emission limits. If the emissions of these substances are reduced beyond what is required by law, the amount reduced beyond the required reduction is considered to be a voluntary emission reduction and is eligible for registration. In summary, emission reductions which are not required by law, or emission reductions that go beyond what is required by law are eligible for registration.

This can be somewhat confusing, and there are situations where it is not clear whether an emission reduction is eligible for registration. The emission reduction registry regulation helps to clarify this confusion by presenting examples of eligible reductions in NR 437.03(1)(a) through (d). These examples are explained here.

i. NR 437.02(1)(a) "VERs that result from actions taken to comply with a law that result in reductions of greenhouse gas or air contaminant emissions that are not required by or go beyond those required by law."

This example covers the situation where a person takes an action to comply with a law which coincidentally results in emission reductions. Those emission reductions may be registered.

A specific example would be when a law requires an electric utility to provide some of its electricity from renewable energy sources, which produce little or no air pollution. This law doesn't require the company to reduce any greenhouse gas or air contaminant emissions, just to provide electricity from renewable sources. But emissions are avoided as a result of taking that action, and those avoided emissions may be registered.

Another example would be the situation where a company is required by law to reduce emissions of one air contaminant, like sulfur dioxide. If the company complies with that law in a way that reduces not only sulfur dioxide emissions, but also reduces emissions of other air contaminants beyond legal requirements, then these ancillary emission reductions may be registered.

ii. NR 437.03(1)(b) "VERs that are made after an applicable law is in effect but before the reduction is required by law."

Many times, when an environmental law is passed, it contains compliance deadlines, which can be several years in the future. Emission reductions made after the law is passed but before the compliance deadline are voluntary reductions and may be registered. Emission reductions made after the compliance deadline may not be registered, unless they go beyond the emission reduction requirements of the law.

iii. NR 437.03(1)(c) "VERs that are made and are reflected in an air pollution control permit, as long as the level of reduction is beyond what is required by law."

Sometimes, when an action is taken to reduce regulated air contaminant emissions, whether it is voluntary or not, DNR and EPA regulations require that the air pollution control permit for the facility be rewritten to reflect the new lower emission level. Thus, a voluntary reduction can result in a new permit requirement, which could be considered to be a legal requirement. But, because of the way that "law" and "mandatory emission limiting requirement in an air permit" are defined in NR 437, a permit condition is not always considered to be a legal requirement. NR 437.03(1)(c) covers the situation where a voluntary action is taken to reduce emissions and the reduced emission rate is then put as a condition in an air pollution control permit. In this situation, the emission reduction may be registered, as long as the emission reduction goes beyond what is required by law.

Here is a concrete example. An automobile assembly plant is required by law to reduce VOC emissions by 75%, and this emission rate is reflected in the company's air pollution control permit. The company installs a stack gas incinerator, which reduces VOC emissions by 95%. The permit is then rewritten to reflect the installation of the new incinerator and the new emission rate. The extra 20% reduction goes beyond what is required by law. Even though it is required in the permit, it is considered to be a voluntary emission reduction and may be registered.

iv. NR 437.03(1)(d) "VERs that are part of a contractual agreement with the department, as defined within the contractual agreement."

Some companies are working with the Department to implement cooperative environmental agreements in which the company agrees to reduce air contaminant emissions by a specified amount, usually a greater reduction than what is required by law. The part of the reduction which goes beyond what is required by current regulatory programs may be registered.

b) The voluntary emission reduction must result from an action to reduce emissions.

It cannot be an emission reduction that just "happened." Thus, emission reductions which result from variations in weather and/or the economy are not eligible for registration. For example, if Company A runs a facility which is heated by coal-fired boilers, they emit many air contaminants from the burning of coal. Suppose a very cold winter is followed by a very mild winter. During the cold winter, the company would need to run the boilers more and burn more coal and emit more air pollution to heat the plant. During the mild winter, the boilers would run less and emit less air pollution. In this case, the emission reduction is not eligible to be registered because it did not result from any action taken by the company to reduce emissions. Some examples of acceptable emission reduction actions are given in NR 437.03(2)(a) through (k), but many other actions are also eligible.

c) The VER has not been registered by any other person under this chapter.

The same VER cannot be registered by two different persons. In situations where two or more persons may be eligible to register the same reduction, those persons need to determine before registration if one person will register the whole reduction, or if the two persons will divide the reduction and register each portion separately.

d) The emission reduction action and the emission reduction must occur in Wisconsin.

Emission reductions which occur outside Wisconsin are not eligible to be registered.

e) For greenhouse gases, the emission reduction may be registered if it occurred after December, 31, 1990. For air contaminants, the emission reduction may be registered if it occurred after December 31, 1993.

Thus, emission reductions may be registered retroactively.

B. Quantification of Emission Reductions

Emission reductions are quantified by subtracting the emissions after the emission reduction action is taken from the emissions before the action is taken. You need to quantify emissions both before and after the emission reduction action is taken. This can be relatively simple or it can be complicated.

Emissions before an action is taken are the baseline emissions. Baseline emissions are discussed in more detail in section C below. This section details how baseline emissions and the emissions after the action is taken are quantified for different types of projects using quantification protocols. This section also discusses how the amount of carbon sequestered is quantified.

1. Direct Emissions and Quantification Protocols

Direct emissions are emitted from a source or process that is owned or operated by the person responsible for the emissions. The owner or operator has control of the emission source. Examples of direct emissions are smokestack emissions from an industrial facility and emissions from a vehicle tailpipe.

NR 437 requires emissions and emission reductions to be quantified using either the quantification protocols listed in NR 437.04(2)(a) or alternative protocols submitted by registrants [see NR 437.04(2)(b)]. A quantification protocol is a replicable and workable method or set of methods for quantifying emissions, emission rates or carbon sequestered

Most of the protocols listed in s. NR 437.04(2)(a) are quantification protocols. They detail how to quantify emissions. One or two of them are quantification and reporting protocols, which means they tell you how to quantify and report emissions. They also deal with boundary issues, additionality, and other relevant topics.

Many of the protocols listed in s. NR 437.04(2)(a) apply to different types of emission sources. Some apply to many types of sources, while others apply to only a few. They generally apply to broad categories of sources, such as point sources, mobile sources, energy efficiency projects, etc. In order to help you determine which protocol is most applicable to your situation, we have developed a table listing all of the protocols. For each protocol, the table identifies the type of protocol and what sources or emission reduction projects it applies to. You can find this table in Appendix A or on the Registry web site at http://www.dnr.state.wi.us/org/aw/air/registry/quantprotocols.html.

There are two methods for quantifying emissions: you can measure them or you can estimate them. Measuring emissions involves either continuous emissions monitoring (CEM) or source emission testing, also known as stack testing. Estimating emissions normally involves the multiplication of activity data by emission factors to calculate emissions. You may also estimate emissions using a material balance technique (see s. NR 437.04(2)(a) for acceptable protocols).

The most accurate way to quantify most emission reductions is to measure emissions before and after the emission reduction action is taken. However, this does not apply to all emitted gases. One notable exception (and there may be others) is the greenhouse gas carbon dioxide. It is difficult to accurately measure CO_2 emissions. It is more accurate to use carbon emission coefficients (emission factors) for each different fuel burned. These emission coefficients are accurately determined and well documented in many of the quantification protocols listed in the registry rule. The emission coefficients give the amount of carbon emitted per unit of fuel burned. Multiply the amount of fuel burned by the carbon emission coefficient for that fuel to obtain accurate carbon or carbon dioxide emissions. A correction factor is generally used to account for incomplete combustion.

Continuous emission monitoring is the most accurate way to measure emissions. However, continuous emission monitors (CEMs) do not exist for all of the air contaminants or greenhouse gases eligible for registration. Also, CEMs are very expensive to purchase, operate, and maintain. For these reasons, the use of CEMs is limited, and it is not anticipated that anyone will purchase and operate a CEM just to document an emission reduction. However, if you already operate CEMs for other reasons, the CEM data are probably the best way to document some air contaminant emission reductions. In Wisconsin, any continuous emissions monitoring must be done in accordance with the methods specified in sections NR 439.09 and 439.095(6), Wis. Adm. Code. These sections of the code are listed under NR 437.04(2)(a).

One problem with CEMs is that they record all emissions, including emission changes which are out of the control of the source owner. Thus, an emission reduction may not be accurately characterized by CEM data if the data include changes in emissions which do not result from the emission reduction action taken. For example, changes in weather can alter emissions without any emission reduction action being taken. The CEM data reflect this change. In this situation, it is very difficult to separate the emissions changes due to weather from those due to the emission reduction action. Thus, you may want to calculate or estimate the emission reduction, even if you have CEM data.

Stack testing (or source emissions testing) is also an acceptable way to measure emissions, as long as the stack test results are representative of emissions during normal operations. Stack testing may be applicable to more sources and more air contaminants than continuous emission monitors. Stack testing must be performed in accordance with sections NR 439.07 and 446.04, Wis. Adm. Code. These sections of the code are listed as the first quantification protocol listed in NR 437.04(2)(a).

Estimating emissions normally involves obtaining appropriate activity or fuel use data for the emission source and finding the correct emission factors which apply to the emission source or process. The activity data are multiplied by the emission factors to obtain the estimated emissions. Activity data normally take the form of number of units produced, amount of raw material used in a process, or amount of fuel burned per unit of time.

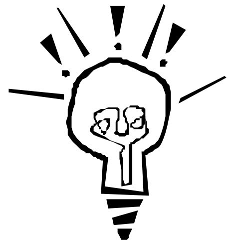
Emission factors are usually obtained from the results of stack tests performed on many similar emission sources. Different quantification protocols contain emission factors for various emission sources. Section NR 437.04 lists 18 quantification protocols (NR 437.04(2)(a) 4 through 21) which provide emission factors that can be used to estimate baselines and emission reductions. Some examples of how emissions are estimated, baselines are determined, and emission reductions are calculated are given in Appendix B.

In some cases, your emission source or process may be so unique that none of the emission factors or methods in these protocols can be used to estimate your emissions. Or you may find that the emission factors in these protocols are not as accurate as other emission factors that you know of. In this situation, NR 437.04(2)(b) allows registrants to use alternative protocols. You need to submit a copy or description of the protocol, documentation of its accuracy and reproducibility, the name and address of the organization that developed the protocol, and whether the protocol has been approved or accepted by any government agency or other organization for registering emission reductions. The Department will maintain a list of alternative quantification protocols submitted and will make the list public so others can locate and use the alternative protocols. The list of protocols will be made available on the registry web site and as a printed document.

If you find that there is no protocol available for quantifying an emission reduction, then you may register the emission reduction action without quantifying the emission reduction itself. When an applicable protocol becomes available, you can then quantify and register your emission reductions for current and previous years.

2. Indirect Emissions

Quantification of emissions and emission reductions or avoided emissions from energy efficiency measures or renewable energy projects is complicated by the fact that these actions reduce indirect emissions. Indirect emissions come from a source that is not owned or operated by the person responsible for the emission reduction. The best example of indirect emissions is the use of electricity from the grid. Most electricity in Wisconsin is produced by large power plants which burn fossil fuels. This produces many air contaminants as well as greenhouse gas emissions. Thus, if you use electricity, you are causing air pollution to be emitted from one or more power plants, most likely located many



miles from your home, factory, or store. In order to quantify the emissions reduced by an energy efficiency measure, you must determine the emission rate for the electricity you conserved which you otherwise would have used. This is not straightforward.

Electricity in the power grid is very complicated. The electricity comes from many sources, including coal-fired power plants, nuclear plants, gas powered combustion turbines, hydropower and wind, and it's generally impossible to determine which electrons are getting to your home or business. Calculating indirect emission reductions is further complicated by the fact that energy efficiency measures may reduce electricity at times of peak electricity use (at the margin) or may reduce emissions at off-peak times (base load), or both. This means that emissions from gas-fired combustion turbines (peaking units) may be reduced, but not emissions from coal-fired power plants (base load units), or vice-versa.

In order to quantify indirect emissions avoided or reduced, it is first necessary to accurately measure the energy saved by an energy efficiency measure or the energy produced by a renewable energy source. The Focus on Energy program (http://www.WIFocusOnEnergy.com) and the *International Performance Measurement and Verification Protocol* [see NR 437.04(2)(a)5.] can help you do this. Once you obtain the number of kilowatt hours saved or produced, you need to know the average (or marginal, in some cases) emission rates for the local utility in terms of mass emitted per kilowatt hour or megawatt hour. The local utility should know the average emission rate for its electricity. It is preferable to use the local utility's emission rates, if available. If not, average emission rates are available from various sources for different regions or states. One good source of average electricity emission rates is the USEPA's Emissions and Generation Resources Integrated Database (EGRID) found on the web at http://www.epa.gov/cleanenergy/egrid/.

The registry rule requires that baseline emissions for energy efficiency and renewable energy projects be calculated using the average system emission rate for the electric utility supplying the avoided electricity [NR 437.05(1)(b)]. However, alternative baselines and quantification protocols are allowed by the rule, so baselines and emission reductions may be calculated in many different ways, as long as the methodology is justified and accurately represents baseline and reduced emissions. Thus, marginal emission rate may be used in cases where marginal emission rates are justified as the best option. In general, the method used should be the method which most accurately reflects the emission reduction.

Indirect emission reductions are especially susceptible to double counting. Please see the discussion on double counting on page 27.

<u>3. Carbon Sequestration</u>

To establish a carbon sequestration project, the project area and boundaries must first be clearly defined. The amount of carbon stored in the project area at the beginning of the project must then be determined. This is the baseline carbon storage for the project. The carbon stored at the beginning of the project (baseline) and the carbon sequestered during the project must be calculated and reported as carbon dioxide. The amount of carbon stored during the project may then be registered on a yearly basis.

The quantification of the amount of carbon sequestered at the beginning and during the project is complicated and involves much uncertainty. Quantification protocols do not yet exist for many carbon sequestration activities. When there is no quantification protocol available, the action taken may be registered without quantifying the amount of carbon sequestered. However, the registration must include a detailed description of the project, including location, number of acres reforested or restored to prairie, number of trees planted, or similar actions. When and if quantification protocols become available, then the amount of carbon sequestered may be calculated and registered for the project.

Note that the amount of carbon sequestered annually in terrestrial ecosystems is variable and uncertain. Thus, reporting the carbon sequestered every year may not be possible or advisable. It may make more sense to measure the carbon sequestered over a longer time period (5 or 10 years) and then determine the annual average carbon sequestered to report to the registry.

4. Quantification and Registration Requirements

Section NR 437.06 contains some additional requirements specifying how baselines and voluntary emission reductions shall be quantified and registered. This section discusses and clarifies these requirements.

Voluntary emission reductions may be quantified and registered on a mass basis (pounds or tons per year) or on a rate basis (tons or pounds per unit of input or output) [NR 437.06(1)].

Voluntary emission reductions must be quantified and registered on a calendar year basis [NR 437.06(4)]. Ozone precursors (nitrogen oxides and volatile organic compounds) may also be quantified and registered for the five-month ozone season (May 1 to September 30) in terms of pounds per day averaged over the ozone season [NR 437.06(3)]. This allows companies located in ozone non-attainment areas to register reductions that could be used to offset emission increases.

Greenhouse gas emissions must be lumped together and registered as carbon dioxide equivalents [NR 437.06(2)]. This means that the emissions of non-CO_2 greenhouse gases (methane, nitrous oxide, HFCs, PFCs, SF_6, etc.) must be converted to equivalent CO_2 emissions by multiplying them by the appropriate global warming potential. Global warming potentials are given in Appendix D.

According to NR 437.06(5), voluntary emission reductions and baselines may be quantified and registered for a project, a facility, or for an entire entity within Wisconsin. For greenhouse gas emission reductions, we strongly encourage entity-wide reporting. If you will be participating in carbon credit trading at the national or international level, you will most likely be required to report entity-wide emissions and emission reductions. This is to prevent what is called “leakage” and to ensure that greenhouse gas emissions have actually been reduced. Leakage occurs when a company reduces emissions at one facility while increasing emissions at other facilities, so their overall emissions increase or stay the same. Leakage is avoided when emissions and emission reductions are reported for all facilities.

The registry rule allows the registration of emission reductions that result from projects to collect, store, and dispose of mercury containing products. However, it is difficult to quantify the air emission reduction (the amount of mercury kept out of the air) from these projects. NR 437.06(6) takes care of this situation by allowing the amount of mercury collected to be registered without quantifying the emission reduction. However, the reduction must be quantified before these mercury reductions can be used for any regulatory or trading program.

C. Baseline Determination

1. Standard Baseline

The registry rule specifies how the standard baseline is determined for both emission reductions and for avoided emissions. As discussed above, avoided emissions are the result of activities which indirectly reduce emissions, such as energy efficiency measures and renewable energy projects.

For emission reductions, the baseline specified in the rule is the average emissions for the two years immediately preceding the year in which the emission reduction action is taken. A two-year average was chosen rather than one year in an attempt to avoid the possible use of a non-representative year as the baseline. The use of a non-representative year could result in an over- or under-estimated emission reduction.

For baseline determination, the rule uses a 2-year timeline but doesn't specify a calendar year (January - December). However, since the rule requires emission reductions to be quantified and registered for the calendar year [see NR 437.06(4)], it may be advisable to quantify the baseline using the two calendar years prior to the year in which the emission reduction action is taken. Since we allow alternate baselines [NR 437.05(2)] in some cases, it may be acceptable to use a non-calendar year for determining the baseline (e.g., April-March or September-August). This makes calculating the emission reduction in the first year problematic, since it only occurs for a few months. It is more straightforward to use calendar years to determine baselines.

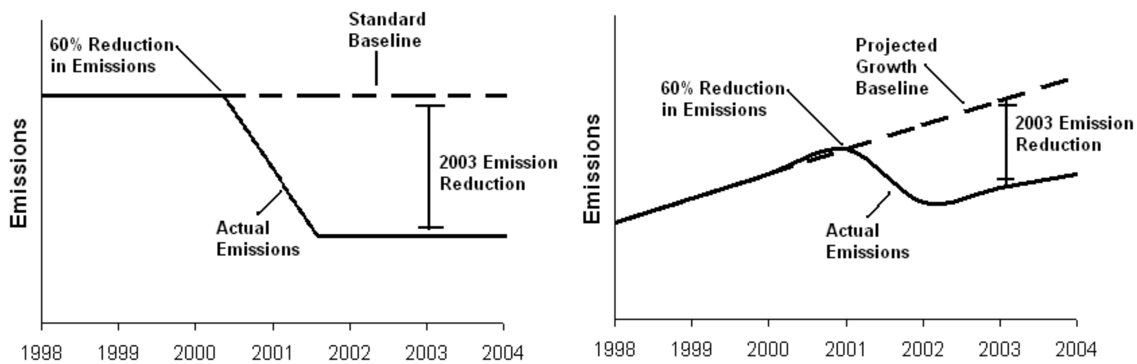
Energy efficiency measures and renewable energy projects result in avoided emissions at the electric utility power plants which supply the electricity where these projects are located. The standard baseline for these projects, as specified in the rule, is the system-wide average electric utility emissions for the two years prior to the year in which the action is taken. The system-wide average is used because it is usually impossible to determine exactly where the electrons going to a specific facility are from.

2. Alternative Baselines

The two-year period immediately preceding the emission reduction action may be non-representative of normal operations and emissions. If this is the case, then you may choose an alternative baseline which is representative of normal operations and emissions. The alternative baseline could use a different set of years, or one representative year.

If you use an alternative baseline, you must provide documentation to the Department explaining why you are using an alternative baseline. This documentation should demonstrate that the standard baseline is not representative of baseline emissions and show how the alternative baseline is representative.

One type of alternative baseline that can be used is the growth baseline, as opposed to the standard historic baseline. Because production and emissions tend to increase over time, the historic baseline does not always work. The growth baseline compares actual emissions for a year with what would have happened without the emission reduction action during that year. For example, a company has been expanding and each year does twice as much business as the year before. If this company switches boiler fuels from coal to natural gas, it will significantly reduce emissions. For this example, we will assume the fuel switch reduces emissions 60%. However, this year's business, and this year's emissions are 100% more than the previous years. This year's emissions are then 40% greater Growth can make it seem that a reduction is smaller than it should be. But, in any given year, the company is emitting less air pollution burning gas than it would have emitted if it was burning coal. So, the emission reduction is determined by using the annual boiler fuel input to calculate the emissions from burning coal and those from burning gas. Subtracting the gas emissions from the coal emissions gives the emission reduction for that year. See Example 3 in Appendix B (page 44) for a more detailed example of how this baseline can be used.



The figures above show emission reductions using both a standard and a growth baseline. On the left is a chart of actual emissions per year. The standard two-year average baseline is shown as a dashed line. In 2001, a fuel change reduced emissions by 60%. The emission reduction is the difference in the two-year average baseline and the actual emissions. On the right is a chart of actual emissions per year with a projected growth baseline (shown as a dashed line). Again, in 2001 emissions were reduced by 60%.

D. Application Procedure

1. Initial Registration

Emission reductions are registered on a calendar year basis. An emission reduction must be registered for each year in which you want recognition for the reduction, even if the reduction doesn't change from year to year.

The application for the initial registration is designed to be simple. After the emission reduction is achieved and properly quantified, the registrant must complete two application forms which are available in hard copy or electronic version. The two forms are the Registrant Information Form (RIF

4500-176) and the Project Information Form (PIF 4500-175). The RIF is used to report registrant information (name, address, type of entity, names of contacts, etc.) The PIF is used to report information about the emission reduction project, including type, location, description, baseline calculation, reduction calculation, etc. If a single entity reports multiple emission reduction projects, they only need to submit the RIF once and submit a separate PIF for each project. The application forms are provided in Appendix E, and the instructions for filling out the application are given in Appendix F. Applications are submitted to:

> The Wisconsin Voluntary Emission Reduction Registry
> Bureau of Air Management
> Wisconsin Department of Natural Resources
> PO Box 7921, Madison, WI 53707.

Note that the registration procedure specified in NR 437.07 in the registry rule requires “A signed and dated statement by a responsible official stating that, to the best of his or her knowledge and belief, the information in the registration form is accurate, all of the requirements of this chapter have been met, and the VERs have not been registered under this chapter by another person." This is required for initial registrations, registration updates, and corrections of historic data. Responsible official is defined in NR 400.02(136) as follows:

> (136) "Responsible official" means one of the following:
> (a) For a corporation, one of the following:
> 1. A president, secretary, treasurer or vice-president of the corporation in charge of a principal business function.
> 2. Any other person who performs similar policy or decision-making functions for the corporation.
> 3. A duly authorized representative of a person listed in subd. 1. or 2. if the representative is responsible for the overall operation of one or more manufacturing, production or operating facilities applying for or subject to a permit and the representative is approved in advance by the department.
> (b) For a partnership or sole proprietorship: a general partner or the proprietor, respectively.
> (c) For a municipality, or a state, federal or other public agency: either a principal executive officer or ranking elected official. For the purposes of this paragraph, a principal executive officer of a federal agency includes the chief executive officer having responsibility for the overall operations of a principal geographic unit of the agency, for example, a regional administrator of EPA.
> (d) Notwithstanding paragraphs (a), (b) and (c), for affected sources, the designated representative.

The last sentence in this definition refers to affected sources and designated representatives under Title IV of the 1990 Clean Air Act Amendments relating to acid deposition control. The term "affected source" means a source that is subject to emission reduction requirements under Title IV. The "designated representative" is the employee of the electric utility company who must sign a statement vouching for the accuracy of the emissions data for the affected source.

2. Annual Registration Update

The annual re-registration is called the registration update in NR 437. The registration update is also easy to do. If the previously registered emission reduction has not changed, then all you need to do is submit copies of the original RIF and PIF forms and a signed statement that the emission reduction has not changed and meets all the requirements of NR 437. Also, let the Department know the year for which the emission reduction is being registered. If you are updating multiple emission reduction projects, then you need only submit one RIF form and multiple PIF forms (i.e., one PIF for each emission reduction project). The DNR recommends that you update your registration at the end of the calendar year for reductions you made in the previous calendar year. There is no deadline for updating your VERs.

If the emission reduction has changed from the previous year, you need to submit a copy of the original RIF, an updated PIF, an explanation of the changes, the recalculated reductions, and a signed statement that the emission reduction is accurate and meets all the requirements of NR 437.

E. Correction of Historic Data

If you register an emission reduction and later find an error in your calculations or if better information becomes available to more accurately calculate the emission reduction, you may correct a registered reduction. To do this, you need to provide the new information to the Department, including the corrected emission reduction and a statement signed by a responsible official in accordance with section NR 437.07(6). You must submit a copy of the original RIF and the corrected PIF with an explanation of the changes. If the information on the RIF should change (such as a change in the company name or a different registry contact), you should submit a revised RIF and check the "revised" box at the top.

F. Department Review

Upon receipt of an application for either an initial registration, a registration update, or a correction of historic data, the Department must determine whether the application contains all of the information required under NR 437.07. The Department must notify the applicant within 90 days after the receipt of an initial registration, update, or correction of its determination. If the application is determined to be incomplete, the Department will specify what information the applicant must submit to complete the application.

The Department will review the application primarily for completeness, but will also do a cursory review to make sure the application makes sense, that acceptable protocols were used to calculate or measure emissions, that baselines were properly determined, and that all the requirements of NR 437 have been met. If problems with the application are found, the Department may ask the applicant to make corrections.

G. Registration

When a completed application is received, the Department will register the emission reduction. This involves entering the pertinent data about the emission reduction into the registry emission reduction table. This table will exist on the registry web site at http://www.dnr.state.wi.us/org/aw/air/registry/ and will also be available in paper copy. All of the registry information will be publicly available. The data entered in the table will include the name of the registrant, the location and type of the emission reduction project, the emission reduction for each pollutant, whether and how the emission reduction was verified, and other pertinent information. No registrant personal contact information will be posted on the registry web site.

VI. Additional Considerations to Keep in Mind When Registering

This section covers some important topics not covered in the registry rules discussed above. These topics should be kept in mind when designing, carrying out, and registering an emission reduction.

A. Verification

Verification of emission reductions or baselines is not required to register a voluntary emission reduction in Wisconsin. However, if you plan to use your registered emission reduction in the future to meet an existing or future regulatory requirement, the emission reduction must meet the standards specified in that requirement. This may require verification of the emission reduction. For existing emission trading programs, it is common practice to have the emission reduction credits verified by a third party. In most cases, the buyer will insist on third party verification. You should consider having your emission reduction verified before registering it if you plan to use it for any purpose which might require it to be verified. Because records may be lost or difficult to retrieve, verification is more easily done soon after the emission reduction is made rather than several years later.

To verify means to establish the truth, accuracy, or reality of (in this case) a voluntary emission reduction. The principle goal of any verification or certification procedure is to ensure the integrity of the emission and emission reduction information reported without imposing an undue burden or expense on registry participants. The following material is provided for those who wish to verify their emission reductions. Since the Wisconsin Registry does not require verification, this material is provided for information only.

1. Verifier's Relationship to the Registrant and the Registry

In general, an emission reduction may be verified by the registrant or by an independent third party. As noted above, the Department will not conduct any verification activities. Verification activities undertaken by the registrant are often known as a "self-audit." Self-audits are considered the least robust, due to the obvious lack of objectivity.

When the verifier is a third party, the robustness of the audit will depend principally on whether the third-party verifier is accredited or not. Accreditation is possible when an independent agency maintains a particular standard or protocol relating to emission reduction audits, and when that agency has a program in place to qualify verifiers against the standard.

The California Climate Action Registry program provides a list of California-certified verifiers. We are not listing or certifying third-party verifiers in Wisconsin, so, if you choose to verify your emission reduction, you need to carefully select a qualified auditor to do the third-party verification. Some of the California-certified auditors may be willing to verify reductions in Wisconsin. The California Climate Action Registry is found on the web at http://www.ClimateRegistry.org.

A third-party verifier achieves objectivity by employing proper language in their contract with the registrant. A written contract is essential to providing legitimacy to a third-party audit. It is also critical to ensure that the relationship is free of conflicts of interest or the appearance thereof. Above all, third-party verifiers must not be actively employed as technical consultants providing emission management services to the registrant. In some cases there may be “gray areas” surrounding this prohibition. For example, the technical support services may have been provided several years prior to the verification activity or the services may be related only to measurement and not related to any specific management program to reduce emissions.

2. Scope of Verification

An audit can examine one or more of: (1) the registrant's emissions management system, (2) the original underlying records, methodologies and activity data used to calculate or estimate the emissions and emission reduction or (3) the emission reduction report. An audit can examine any one or any combination of these three subject areas. None of the three is inherently "more important" than the others, but those audits that include all three are considered the strongest. A thorough and rigorous verification would involve the following:

- Verify ownership of the emission reduction.
- Inspect the emission reduction, carbon sequestration, or emission avoidance project to ensure that the emission reduction action was taken.
- Check to ensure that any source emission testing or other measurement was done correctly and properly. This is best done by witnessing the test procedure while it is being done.
- Make sure that the appropriate quantification protocol is used and that it is properly applied.
- Check the applicability and accuracy of any emission factors used.

- Check the validity and accuracy of all source activity data and any other input data.
- Make sure the baseline is properly determined.
- Check to see that all calculations are done correctly.
- Check to see that emission reductions are properly and accurately reported.
- Ensure that all requirements of chapter NR 437 have been met.

This type of rigorous verification is best done by a third-party auditor, but can be done by the registrant (self-verification). A less rigorous verification would involve doing only some of the steps listed above. The rigor of the verification may vary depending on legal requirements. Some emission reduction regulations may require third party verification, while other programs (such as this registry) may require no verification.

3. Tiers of Verification

The nature of the verifier's relationship to the registrant, the accreditation status of the verifier, and the scope of the verification activity, together define the audit's robustness. Based on these factors, three tiers of verification may be defined that vary from the most easily implemented and least robust (Tier 1) to the least easily implemented but most robust (Tier 3).

•Tier 1 – Self-audits and report consistency checks

Under Tier 1, reporting companies should, at a minimum, conduct and document quality assurance and quality control procedures. No formal reporting requirement and no independent check is required. Self-audits and reporting should be conducted as much as possible according to published standards, such as ISO 14010, and the Global Reporting Initiative.

•Tier 2 – Registry audits and unaccredited third-party verification

Tier 2 audits must involve, at the very least, review of calculations used to generate the emission reduction report.

•Tier 3 – Accredited verification (sometimes also known as certification)

Under Tier 3 verification, each submission is audited by an accredited, third-party verifier under a contractual relationship with the registrant. Tier 3 verification may require a multidisciplinary team conducting in-depth site audits and interviews with company experts in the instance of a complex corporate program. Often external data and records are employed to corroborate internal reports. This level of auditing is particularly appropriate for emission reductions which will be traded or used as offsets.

B. Record Keeping and Documentation

Record keeping and documentation are not required by the registry rule. However, emission reduction registrants are advised to keep detailed records of all information pertinent to the emission reduction and the emission reduction activity. This information will be needed if and when the emission reduction is used. This is especially true if the emission reduction has not been verified and the registrant may want to have it verified at some point in the future. It is much easier to verify an emission reduction at the time when the emission reduction is made than to do it several years later.

The type of records which should be kept are primarily records of fuel burned (type of fuel, quantity burned, BTU content, sulfur content, etc.) or facility activity data (process throughputs, raw materials used, electricity used, energy saved, etc.) which are used to calculate or estimate the emission reduction. Records of the emission factors used, results from continuous emissions monitoring or stack testing, and the baseline and emission reduction calculations should also be kept.

C. Double Counting

Double counting of emission reductions is strictly prohibited. An emission reduction may be registered by only one entity. In most cases, double counting is not likely. However, double counting could possibly occur in a couple of situations.

1. Shared Ownership

If an emission source or emission reduction project is owned by more than one person or business and a voluntary emission reduction is made at the source, the owners must determine, before they apply to register the emission reduction, exactly how much of it each of them owns and may register. This would normally be done based on the ownership share of each owner. For example, a company that owns 50% of the source can claim 50% of the emission reduction. Under no circumstances may two people claim the same emission reduction.

2. Indirect Emission Reductions

If a person reduces or avoids emissions at a power plant by reducing his or her electricity use (through actions unrelated to a utility-sponsored energy efficiency program), it is possible that the electric provider, as well as the person taking the action, could claim the emission reduction. However, this is prevented by s. NR 437.03(2), which specifies that an emission reduction may only be registered if it is the result of an action taken. Thus, the electricity provider, which, in this case, took no action to reduce emissions, may not register the reduction or avoided emissions.

This situation changes if the entity that funds, or otherwise initiates an energy efficiency program (a utility, public agency or private firm) takes one or more actions which result in a reduction in electricity use by the end user, or if the end-user agrees to sell or give the rights to the emission reduction to another entity. For example, many efficiency projects are partially funded by more than one entity. A business may partially fund a project, but include rebate funding from the Focus on Energy program and additional funding from its electric provider. In these cases, the cooperating parties must agree, preferably by contract, on an division of emission reductions that does not exceed the reductions actually achieved. Clearly, if an electricity provider gives compact fluorescent bulbs to its customers, the utility company can claim the reduction, since the electric utility paid for the bulbs, not the customer. Alternatively, compact fluorescent bulbs could come with a mail-in agreement (possibly with a rebate) which, when signed by the end-user, transfers the rights to the emission reductions to the program sponsor. In this way the program sponsor buys the right to the emission reductions from the end-user.

In many instances a program sponsor runs an energy efficiency program through ads and promotion, but does not pay directly for the end use efficiency action. In these programs, the program sponsor will not be able to claim any emission reduction unless it can establish that an emission reduction is causally linked to the energy efficiency program and that no other person has attempted to claim the reduction.

VII. How Can I Use My Registered Emission Reductions?

Registered emission reductions may be used for two main purposes: they may be used to meet existing or future emission reduction requirements or they may be traded. Early reductions may be used to meet future emission reduction requirements. Reductions of volatile organic compounds and nitrogen oxides that go beyond requirements in ozone non-attainment areas may be transferred and used as offsets by sources that can't reduce emissions or need to increase emissions. Sulfur dioxide emission reductions may be traded on the existing sulfur dioxide allowance market, and carbon dioxide emission reductions may be traded on the currently developing carbon credit markets.

This section discusses the requirements of existing regulatory programs and the likely requirements of future regulatory programs in which emission reductions may be used. It identifies some of the things you can do to prepare for those regulatory requirements. Each regulatory program has its own specific requirements. In all cases, keeping detailed records and documentation, in addition to the information provided in the registry, is recommended, even though it is not required by the registry rule.

A. Existing Regulatory Programs

1. Air Permits

a) Netting

In construction permitting, it is possible that voluntary emission reductions could potentially be used to internally offset emission increases that are associated with a new project, if the project occurs at a major source.

b) Emission Reduction Credits

Voluntary emission reductions occurring within ozone non-attainment areas in eastern and southeastern Wisconsin could potentially be converted to emission reduction credits. Emission reduction credits may be transferred to other entities for use in offsetting emissions from a new project, provided that the requirements in chapter NR 408, Wis. Adm. Code are met. Offsets are required for new or modified major sources emitting volatile organic compounds.

For more information about the permitting program, contact Jeff.Hanson@dnr.state.wi.us or at 608-266-6876.

2. Transportation Conformity

The federal Clean Air Act requires that transportation programs and plans conform to the air quality plans in ozone and carbon monoxide non-attainment areas. Attainment or maintenance State Implementation Plans for these non-attainment areas establish an emissions budget or "ceiling" for NOx and VOC emissions or CO emissions from highway vehicles in the area. Transportation programs and plans cannot proceed unless they meet the emission budget test for conformity. Although voluntary mobile source emission reductions are difficult to quantify, they may be counted for conformity purposes (reducing highway vehicle emissions) with no restrictions.

For example, if the state and/or municipality develops a plan to alter transportation infrastructure in an ozone non-attainment area (like the Marquette interchange project in Milwaukee), they may not proceed with the project until they show that it will not cause the NOx or VOC budget for the Milwaukee ozone non-attainment area to be exceeded. If the budget will be exceeded, then voluntary mobile source emission reductions may be used to ensure that the budget is not exceeded by the project.

For more information, contact Larry.Bruss@dnr.state.wi.us or 608-267-7543

3. Reducing Concentrations in Potential Non-attainment Areas

EPA typically uses the most recent monitoring data to designate non-attainment areas. Voluntary measures may play a role in reducing concentrations of air contaminants prior to designation. Early implementation may help to limit the severity of the classification of or avoid non-attainment designation. For ozone non-attainment areas, 1 ton per day of NOx emission reduction will reduce peak ozone concentrations by about 0.06 ppb. One ton/day of VOC emission reduction will reduce peak ozone concentrations by approximately 0.05 ppb. These "equivalencies" will vary on any given day, hour and location.

For more information, contact Larry.Bruss@dnr.state.wi.us or 608-267-7543

B. Possible Future Regulatory Programs

1. Greenhouse Gas Programs

It is possible that greenhouse gas emission reductions will be required at some time in the future. The greenhouse gas regulations may take the form of a national cap and trade system. Individual emitters may be assigned emission reductions or issued CO_2 emission allowances, similar to the SO_2 allowances issued under the acid rain program. If emissions are reduced below what is required, the excess emission reductions may be sold or banked. Any emission reduction trading market will likely have rules set by the federal government. A national emission reduction registry may be used to track emission reductions. Greenhouse gas emission reductions registered in the Wisconsin emission reduction registry may be recognized under the national program, depending on what the rules of the national program are.

For more information, contact Eric.Mosher@dnr.state.wi.us or 608-266-3010.

2. State Implementation Plans

In general, state implementation plans (SIPs) are developed by states to regulate or to make a commitment to regulate air pollutants or improve visibility. States develop SIPs to satisfy federal requirements in the Clean Air Act. In some cases, voluntary reductions may be used to help meet SIP requirements.

a) Fine Particulate Matter

In 1997 EPA promulgated a fine particulate matter standard, (PM2.5). However, an executive order accompanying the promulgation of the standard prohibited EPA from enforcing the standard until they completed another review of the health effects associated with exposure to fine particulate matter. EPA will complete that review, probably in 2003. Provided that the PM2.5 standard survives all of the legal challenges, EPA will then designate non-attainment areas and require SIPs to correct any fine particulate matter problems in the 2007-2008 time frame. Even if Wisconsin does not have any PM2.5 non-attainment areas, it is likely that Wisconsin sources may have emission reduction requirements to mitigate the effects of transported PM2.5 and PM2.5 precursors (SO2 and NOx, see discussion under Regional Haze page 30. It is also likely that regional planning organizations will develop multi-pollutant approaches to reduce PM2.5 and ozone concentrations, and improve visibility. See Regional Haze and Ozone Programs for more details. However, it is not clear at this time how those programs will operate or determine compliance, but EPA guidance is available to states to take credit for voluntary mobile source and stationary source emission reductions. Links to these guidance documents are given in section D below.

For more information, contact Larry.Bruss@dnr.state.wi.us or 608-267-7543

b) Regional Haze

In response to a Clean Air Act requirement, in 1999, EPA promulgated rules to improve visibility in 156 "Class I" areas, mostly pristine areas, national parks or national monuments. In response, states are required by 2008 to submit SIPs indicating how they will reduce emissions to improve visibility in the Class I areas. EPA is currently working to integrate the SIP submittal timelines for PM2.5, regional haze and ozone, since many of the same sources contribute to all three problems. It is not clear at this time how EPA will integrate those programs or determine compliance, but EPA guidance is available to states to take credit for voluntary mobile source and stationary source emission reductions (see Section D below).

It should be noted that, while PM2.5 is directly emitted from some processes, a significant amount is also formed in the atmosphere from emissions of SO_2 and NOx. However, there currently are no reliable methods for determining how much PM2.5 is reduced by reducing "X" tons of SO_2 or NOx over a given time period. EPA's Best Available Retrofit Technology (BART) requirements under the regional haze rules list SO_2 and NOx emission controls as options for regional haze control. Thus, registered SO_2 and NOx emission reductions could potentially be used to meet future regional haze requirements.

For more information, contact Larry.Bruss@dnr.state.wi.us or 608-267-7543 *c) Ozone State Implementation Plans*

Southeastern Wisconsin continues to be a non-attainment area for the one-hour ozone standard. We came close to attaining the standard during the three-year period from 1999 through 2001. However, numerous exceedances of the standard occurred in the summer of 2002, delaying attainment.

In 1997, EPA promulgated an 8-hour ozone standard. However, legal battles have prevented EPA from implementing the standard. EPA anticipates that they will have developed a legal implementation plan by 2003 and will have identified 8-hour ozone non-attainment areas by 2004. It is also likely that states working with their regional planning organizations will develop multi-pollutant approaches to reduce ozone concentrations along with improving visibility and reducing PM2.5 concentrations. However, it is not clear at this time how those programs will operate or determine compliance, but EPA guidance is available to states to take credit for voluntary mobile source and stationary source emission reductions.

More detail is provided below related to specific elements of ozone SIPs.

i. Rate of Progress

Rate of progress (ROP) provisions in the Clean Air Act require states with 1-hour ozone non-attainment areas to reduce emissions of NOx and/or VOC by 3% per year. Although it is not certain at this time, it is likely that some ROP provisions will be a required element of an 8-hour ozone SIP. Current EPA guidance allows 3% of the ROP emission reduction requirement to come from voluntary measures. If an area fails to meet a rate of progress milestone, it is required to implement contingency measures. EPA allows a limited use of voluntary measures as contingency measures.

ii. Attainment Demonstration

An attainment demonstration is a SIP that shows how a state will correct an air quality problem (bring a non-attainment area into attainment with the national air quality standards). Current EPA guidance allows 3% of the necessary reduction in an attainment demonstration to come from voluntary mobile and point source reductions. For ozone, the next attainment plan is likely to be the attainment plan for the 8-hour standard, probably due in 2007 to 2008 .

EPA is in the process of developing an implementation plan for the 8-hour standard. This plan, to be finalized in 2003, will define a non-attainment area classification scheme, required control programs for non-attainment areas, and other important aspects of the 8-hour ozone standard implementation plan. EPA expects to designate non-attainment areas in 2004. DNR will develop an ozone attainment demonstration for the 8-hour standard in concert with the other Lake Michigan States. It’s likely that additional NOx or VOC emission reductions will be required to control ozone in Wisconsin and/or in Western Michigan. Voluntary emission reductions that go beyond the current non-attainment area requirements may be used to meet the future SIP requirements.

iii. Maintenance Plan

The Clean Air Act requires a maintenance plan when an area is redesignated from non-attainment to attainment. As part of the maintenance plan, states develop a contingency plan, in case further violations of the standard occur after the area is redesignated to attainment. Voluntary measures can be used as contingency measures with some limitations. EPA allows states to select either NOx or VOC contingency measures using a public process identified in the maintenance plan.

For more information on the ozone SIP, contact Larry.Bruss@dnr.state.wi.us or 608-267-7543

3. NOx Trading

Many new non-attainment areas will be designated under the 8-hour ozone standard, and EPA may initiate a new NOx SIP Call to limit interstate transport into these new non-attainment areas. If this is the case, Wisconsin sources may need to make additional NOx reductions to limit their effects on downwind non-attainment areas, most likely in Michigan. As with the current NOx SIP Call, sources may be allowed to opt into the program to trade emission reduction credits. However, to participate in the trading, any source will be required to accept enforceable emission limitations.

For more information, contact Larry.Bruss@dnr.state.wi.us or 608-267-7543

4. Alternative Fuel Vehicle Requirements

On April 17, 1998, United States Department of Energy published an Advanced Notice of Proposed Rulemaking (ANOPR) (http://www.ott.doe.gov/pdfs/anopr.pdf.) under the Environmental Policy Act of 1992 (EPACT) concerning possible alternative fuel vehicle (AFV) requirements for private and local government fleets. Currently EPACT mandates apply only to state and fuel provider fleets. EPACT requires 75% of new vehicle purchases for model year (MY) 2001 and after to be alternatively fueled vehicles. Law enforcement, emergency and off-road vehicles are exempt from purchase requirements. Violators may receive monetary penalties (per vehicle/per day) until they meet EPACT compliance standards.

The ANOPR addressed the fleet acquisition program within Section 507(g) of EPACT, as well as possible alternative fuel requirements for urban transit bus fleets, in accordance with Section 507(k). Under 507(g) of EPACT, the following are recognized as alternative fuels: methanol and denatured ethanol as alcohol fuels (alcohol mixtures that contain no less than 70% of the alcohol fuel), natural gas (compressed or liquefied), liquefied petroleum gas, hydrogen, coal-derived liquid fuels, fuels derived from biological materials, and electricity (including solar energy). The Energy Conservation Reauthorization Act of 1998 amended EPACT to include use of biodiesel by fleets as a means of compliance with EPACT. Fleets must use minimum 20% biodiesel blend (B20). One vehicle credit equals 450 gallons of biodiesel in the blend , which cannot be saved or traded.

If the ANOPR takes effect, private, local and government fleets may be required to meet the following new vehicle purchase requirements for the requisite model years (MY) following implementation. MY

1- 20%, MY 2- 40%, MY 3- 60%; MY 4 and after- 75%. If this rule goes into effect, registered mobile source emission reductions from the purchase of alternatively fueled vehicles could be used to meet these requirements.

For more information, contact Muhammed.Islam@dnr.state.wi.us or 608-264-9219

5. Wisconsin's Proposed Mercury Regulation

In June 2003 the Natural Resources Board adopted a state mercury rule. The rule is currently in legislative review.

The following are the major provisions of the adopted rule. Requirements for major electric utilities apply on an in-state facility-wide basis and not on an individual plant basis.

Mercury Baseline – By October 1, 2005, major electric utilities would be required to submit a report to the Department with the following information:

1. Average coal usage for the years 2002, 2003, and 2004.
2. Sample test results of the fuel mercury content from coal in 2004.
3. Results of emissions testing with the mercury capture efficiency of currently installed air pollution control equipment.

The results of coal usage and coal mercury content would be used to determine a mercury baseline for each major electric utility and will be the point from which mercury reductions will be required.

Mercury Emissions Cap – The emissions testing with current mercury control efficiency will be used along with the established mercury baseline to establish a mercury emissions cap for each major electric utility. Beginning January 1, 2008, major electric utilities would not be allowed to exceed their mercury emissions cap.

Compliance Plan - By October 1, 2007 and October 1, 2011, utilities would be required to submit a compliance plan to the Department with a proposal detailing how the utility intends to comply with the baseline emission reduction requirements in the rule.

Reduction Requirements – Major electric utilities would be required to achieve the following reductions in mercury emissions from baseline emissions by the following dates after rule promulgation:

1. By January 1, 2010 – 40% reduction.
2. By January 1, 2015 – 80 % reduction.

Compliance – Major electric utilities would be allowed to achieve compliance using a combination of control technology, fuel switching, efficiency in boiler operation, boiler shutdown, or emissions trading between major electric utilities.

Multi-pollutant Option – Major electric utilities would be allowed to pursue a multi-pollutant reduction approach for mercury and other air pollutants.

Variances – In consultation with the Public Service Commission, the Department would be allowed to grant variances to major electric utilities based on a demonstration that the technology or economic costs are not feasible.

Electric Reliability Waiver – A waiver from an annual mercury emission limitation may be approved if the cause of excess emissions is related to an issue of electric reliability. The Public Service Commission would be consulted and a 30-day public comment period with a hearing opportunity would be offered.

Evaluation Reports – The Department would be required to prepare rule assessment reports to the Natural Resources Board by January 1, 2006 and January 1, 2009, taking into consideration electric reliability, scientific and technology developments, multi-pollutant reduction approaches, and federal regulatory activity. The report would include an evaluation of the feasibility of achieving the reduction requirements and recommendations for corrective actions and rule revisions. The department would be required to update the report by January 1, 2013. In addition to these evaluation reports, the department would be required to submit a report within six months of promulgation of federal regulations or enactment of a federal law that requires mercury reductions from sources affected by this rule.

New Sources – New sources with allowable mercury emissions of 10 pounds or more per year will be required to apply BACT (Best Available Control Technology).

Source Reporting – All sources with emissions of 10 pounds or more of mercury per year would be required to meet the measurement and reporting requirements of the rule.

For more information, contact Jon.Heinrich@dnr.state.wi.us or 608-267-7547.

C. Non-regulatory Programs

1. Wisconsin Partners for Clean Air

The objective for Wisconsin Partners for Clean Air is to voluntarily reduce emission of NOx or VOC on Ozone Action Days (days when concentrations of ozone are expected to be high). There are no restrictions on the use of voluntary measures on ozone action days. The Wisconsin Partners for Clean Air web site provides useful information on reducing NOx and VOC emissions at your home and place of business.

For more information, contact Gerald.Medinger@dnr.state.wi.us , 414-263-8659 or Jessica.Laub@dnr.state.wi.us, 414-263-8367.

D. EPA Guidance Documents on Voluntary Measures

The sections above about State Implementation Plans for fine particulate matter, regional haze and ozone all refer to USEPA guidance documents on how voluntary measures may be used to meet SIP requirements. The guidance documents and links to them are given here.

There are two principal EPA guidance documents that provide information on using stationary source voluntary measures for regulatory purposes:

Improving Air Quality with Economic Incentives Programs, EPA-452/R-01-001, January 2001
http://www.epa.gov/ttn/oarpg/t1/memoranda/eipfin.pdf

Stationary Source Voluntary Measures Draft Policy, June 1, 2000
http://www.epa.gov/ttn/oarpg/t1/memoranda/vmpol601.pdf

For mobile sources, Guidance on Incorporating Voluntary Mobile Source Emission Reduction Programs in State Implementation Plans can be found on EPA's TTN web site as well at:
http://www.epa.gov/ttn/oarpg/t2pgm.html

Appendix A - Measurement, Quantification, and Reporting Protocols

No.	Title	Published By	Type of Protocol	Applicable Sources	Web Location
1	Source Emission Testing	WI DNR	Measurement	Stationary sources, smokestacks	http://www.legis.state.wi.us/rsb/code/nr/nr400.htmlhttp://www.legis.state.wi.us/rsb/code/nr/nr400.html
2	Continuous Emission Testing	WI DNR	Measurement	Stationary sources, smokestacks	http://www.legis.state.wi.us/rsb/code/nr/nr400.html
3	Mass Balance Estimates		Estimation	Industrial processes	None
4	*Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*	IPCC	Reporting and Quantificatiom	Greenhouse gas sources	http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm
5	*International Performance Measurement and Verification Protocol*	USDOE	Electricity Use Measurement and Verification	Energy efficiency and renewable energy projects	http://www.ipmvp.org
6	*Compilation of Air Pollutant Emission Factors, Volume 1: Stationary, Point, and Area Sources*	USEPA	Quantification	Stationary, point and area sources	http://www.epa.gov/ttn/chief/ap42/index.html
7	*Compilation of Air Pollutant Emission Factors, Volume 2: Mobile Sources*	USEPA	Quantification	Mobile sources	http://www.epa.gov/otaq/ap42.htm
8	*Compilation of Air Pollutant Emission Factors, Volume 2: Mobile Sources*, Appendices G to K	USEPA	Quantification	Mobile sources	http://www.epa.gov/otaq/ap42.htm
9	*EIIP Volume I – Introduction to the Emission Inventory Improvement Program*	USEPA	Quantification and Reporting	All sources	http://www.epa.gov/ttn/chief/eiip/techreport/volume01/index.html

10	*EIIP Volume II – Point Sources*	USEPA	Measurement, quantification, and reporting	Point Sources	http://www.epa.gov/ttn/chief/eiip/techreport/volume02/index.html
11	*EIIP Volume III – Area Sources*	USEPA	Quantification	Area sources	http://www.epa.gov/ttn/chief/eiip/techreport/volume03/index.html
12	*EIIP Volume IV – Mobile Sources*	USEPA	Quantification	Mobile Sources	http://www.epa.gov/ttn/chief/eiip/techreport/volume04/index.html
13	*EIIP Volume VI – QA/QC*	USEPA	QA/QC, Verification	All sources	http://www.epa.gov/ttn/chief/eiip/techreport/volume06/index.html
14	*EIIP Volume VII – Data Management*	USEPA	Data Management	All sources	http://www.epa.gov/ttn/chief/eiip/techreport/volume07/index.htmlhttp://www.epa.gov/ttn./chief/eiip/techreport/volume07/index.html
15	*EIIP Volume VIII – Greenhouse Gases*	USEPA	Quantification	Greenhouse gas sources	http://www.epa.gov/ttn/chief/eiip/techreport/volume08/index.html
16	*EIIP Volume IX – Particulate Emissions*	USEPA	Quantification and Validation	Particulate Sources	http://www.epa.gov/ttn/chief/eiip/techreport/volume09/index.html
17	*Voluntary Reporting of Greenhouse Gases under Section 1605(b) of the Energy Policy Act of 1992 – General Guidelines*	USDOE	Quantification and Reporting	Greenhouse gas sources	http://www.eia.doe.gov/oiaf/1605/1605b.html
18	*Sector-Specific Issues and Reporting Methodologies Supporting the General Guidelines for 1605(b), Volume 1 – Electricity Supply, Residential and Commercial Buildings, and Industrial Sector*	USDOE	Quantification and Reporting	Greenhouse gas sources in the electricity supply, residential, commercial, and industrial sectors	http://www.eia.doe.gov/pub/oiaf/1605/cdrom/pdf/gg-vol1.pdf

19	*Sector-Specific Issues and Reporting Methodologies Supporting the General Guidelines for 1605(b), Volume 2 – Transportation, Forestry, and Agriculture*	USDOE	Quantification and Reporting	Greenhouse gas sources in the transportation, forestry, and agricultural sectors	http://www.eia.doe.gov/pub/oiaf/1605/cdrom/pdf/gg-vol2.pdf
20	*The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard*	WRI & WBCSD	Quantification and Reporting	Greenhouse gas sources	http://www.ghgprotocol.org
21	*GHG Calculation Tools*	WRI & WBCSD	Quantification	Greenhouse gas sources	http://www.ghgprotocol.org/standard/tools.htm
22	*Factor Information Retrieval Data System (FIRE),* version 6.23	USEPA	Quantification		http://www.epa.gov/ttn/chief/software/fire/index.html

Appendix B - Wisconsin Voluntary Emission Reduction Registry Examples

Example 1 - Boiler Tune-Up

Steve-O's Widgets Inc. operates a boiler to produce process steam. Steve-O's boiler is a pulverized coal, dry bottom, wall-fired unit burning subbituminous coal. The boiler has no emission controls. In 2001, Steve-O performed a tune-up on the boiler, which increased boiler efficiency from 25% to 30%. The boiler steam output and combustion process remained the same before and after the tune-up. At 25% efficiency, 100,000 tons of coal is burned in the boiler annually. At 30% efficiency, the boiler burns 83,333 tons of the same coal annually to produce the same amount of steam.

It is important to note that the capacity of the boiler may have been increased by the increase in efficiency. An increase in boiler capacity could trigger New Source Performance Standards and possibly also Prevention of Significant Deterioration requirements. This could affect the magnitude of the emission reduction which could be registered. For this example, we assume that the capacity of the boiler is not increased by the boiler tune-up.

Emission factors from AP – 42[1] for Steve-O's type of coal boiler are given in Table 1. These emission factors are used to calculate estimated emissions by multiplying the total tons of coal combusted in Steve-O's boiler by the emission factor.

Table 1 - AP-42 Emission Factors for Steve-O's Coal Boiler

Air Emission	Emission Factor (pounds per ton of coal burned)
CO_2	4810
SO_2	35
NO_x	12
Hg	0.0003598[2]
PM 2.5	0.6
PM 10	2.3
Total PM	10
N_20	0.03
CH_4	0.04
CO	0.5

1 *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary, Point, and Area Sources,* USEPA, AP-42, 5th edition, January 1, 1995, as revised by Supplements A to F and Update 2001. http://www.epa.gov/ttn/chief/ap42/index.html
2 The AP-42 emission factor is 16 pounds of mercury per 10^{12} BTU. The year 2000 value of 22.489 million BTU per short ton of coal (from the Energy Information Administration Annual Energy Review 2001, Table A5. Approximate Heat Content of Coal and Coal Coke, 1949-2000 at http://www.eia.doe.gov/aer/append.html) was used to estimate the value of pounds of mercury per ton of coal burned.

The key to calculating Steve-O's reportable emission reductions is the baseline determination. Widgets Inc. combusted 125,000 tons of coal in 1998, 75,000 tons in 1999, and 100,000 tons in 2000 with the 25% efficient boiler. The emission reduction registry rule requires a two-year average for the standard baseline, but is sufficiently flexible to allow any reasonable baseline calculation. In this case, Steve-O determined that the two years prior to the boiler tune up were not representative of his typical coal combustion. 1999 was a tough year for widgets, so Steve-O extended his baseline to three years to better represent typical coal use. Thus Steve-O's baseline equals the average amount of coal combusted from 1998-2000, which is 100,000 tons per year.

Using the emissions factors from Table 1, the calculated baseline of 100,000 tons, and the efficient boiler coal volume of 83,333 tons, Steve-O can calculate his emission reductions, as illustrated for coal CO_2 emissions, below.

Baseline Emissions Example

100,000 tons of coal * 4810 lbs CO_2 per ton of coal combusted = 481,000,000 lbs CO_2

481,000,000 lbs CO_2 * (1 ton/2000 lbs) = 240,500 tons CO_2

2001 Emissions Example (Following Tuneup)

83,333 tons of coal * 4810 lbs CO_2 per ton of coal combusted = 400,831,730 lbs CO_2

400,831,730 lbs CO_2 * (1 ton/2000 lbs) = 200,416 tons CO_2

Following calculation of baseline and project year emissions, reductions can be calculated by subtracting efficient boiler emissions from the inefficient boiler emissions.

Emission Reduction Calculation

240,500 tons CO_2 - 200,416 tons CO_2 = **40,084 tons CO_2 = Emission Reduction**

All of Steve-O's emission reductions were calculated in this fashion, and are provided in Table 2.

Steve-O is almost ready to fill out his Project Information Form, but he must first convert the greenhouse gases N_20 and CH_4 into CO_2 equivalents as prescribed by the registry rule. Using EPA global warming potentials,[3] 0.25 tons of N_20 is equivalent to reducing 77.5 tons of CO_2. Similarly, reducing 0.33 tons of CH_4 is equivalent to reducing 6.93 tons of CO_2. Detailed calculations for N_20 and CH_4 are included below.

3 The global warming potentials used in this example are from the Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report, and are given in Appendix D.

Table 2 - Steve-O's Reportable Emission Reductions

Air Emission	Baseline Emissions (25% efficiency)	Units	Annual Emissions at 30% efficiency	Units	Registered Annual Emission Reduction	Units
CO_2	240,500	Tons	200,416	Tons	40,084	Tons
SO_2	1,750	Tons	1,548	Tons	202	Tons
NO_x	600	Tons	500	Tons	100	Tons
Hg	36	Lbs	30	Lbs	6	Lbs
PM 2.5	30	Tons	25	Tons	5	Tons
PM 10	115	Tons	96	Tons	19	Tons
Total PM	500	Tons	417	Tons	83	Tons
N_20	1.5	Tons	1.25	Tons	.25	Tons
CH_4	2	Tons	1.67	Tons	.33	Tons
CO	25	Tons	21	Tons	4	Tons

Global Warming Potential (GWP) Calculations

0.25 tons N_20 * 296 (IPCC GWP value for N_20) = 74 tons CO_2

0.33 tons CH_4 * 23 (IPCC GWP value for CH_4) = 7.6 tons CO_2

When Steve-O fills out his Project Information Form, he will report emission reductions of 40,084 tons of CO_2 (the estimated amount of actual carbon dioxide reduced) plus 77.5 tons for the N_20 and 6.93 tons for the CH_4. For 2001, Steve-O will register emission reductions of 40,166 tons of greenhouse gas emissions (reported as CO_2 equivalents) along with the emission reductions for the other non-greenhouse gas emissions.

Example 2 - Product Redesign and Emissions Aggregation

Anthony's Audio Components Inc. produces stereo receivers. Last year, Joe, the production engineer, devised a way to build a new type of receiver, called the Optimizer, which uses 75% less electricity without sacrificing sound quality. Anthony's Audio Components began producing this new receiver in 2002. Anthony, the CEO, wants to register the emission reductions from the more efficient product he has made for consumers. He decides to offer a Wisconsin resident rebate coupon with each receiver that stipulates, upon reimbursement, the consumer transfers all emission reduction rights to Anthony's Audio Components Inc. Anthony collects the returned rebates and aggregates them as described below.

The typical audio/video stereo receiver uses most of its electricity when it is in the off mode, or plugged in and not actively powering speakers. A receiver in the average Wisconsin citizen's home consumes about 2 watts per hour in off mode, while the Optimizer consumes only 0.5 Watts per hour[4]. The two receivers use comparable amounts of energy in on-mode, with the Optimizer being slightly more efficient.

Even with this information in-hand, Anthony is still confused about how to calculate the benefits of his receiver versus the average receiver. Fortunately, the USEPA Energy Star program recognizes the difficulty of such calculations, and has developed a number of tools to help people calculate energy savings. After learning of the Stereo Receiver Energy Savings Calculator available on the Energy Star web site[5], Anthony plugs his data into the calculator and determines that one of his receivers saves 13 kWh per year versus one of the average population's receivers[6] (see Table 3).

The next step is to determine the number of receivers for which Anthony can claim credit. Let's assume Anthony sells 100,000 receivers in Wisconsin in 2002, and has a rebate return rate of 50%. Anthony gets to claim the emission reductions from 50,000 receivers for 2002. The Savings Calculator also allows calculation of kWh savings from multiple units, so Anthony plugs his data into the calculator and determines that the energy savings associated with Optimizer sales in Wisconsin in 2002 are 626,950 kWh per year.

The next important step Anthony must consider is what grid emission factors to use. The energy reduction due to his receivers in Wisconsin displaces 626,950 kWh of electricity from the grid, along with the associated emissions. It is important to use accurate emission factor to ensure a quality emission reduction estimate. Anthony decides to use the emission factors given in Table 4. Note that the mercury emission factor is given in pounds per GWh, while the other emission factors are given in pounds per MWh.

Anthony uses the factors in Table 4 to determine the emissions from 626,950 kWh worth of grid emissions in Wisconsin. CO_2 emissions are used to illustrate how Anthony calculated his emission reduction.

CO_2 Emission Reduction Calculations

626,950 kWh (displaced grid electricity) * (1MWh/1000kwh) = 626.95 MWh

626.95 MWh * 1851 Pounds CO_2/MWh = 1,160,484 pounds CO_2

1,160,484 pounds CO_2 * (1 ton/2000 pounds) = **580 tons = Emission Reduction**

4 This number, 2 watts per hour, is an EPA estimate based on a Lawrence Berkely National Laboratory analysis of stereo receivers. A registrant actually using this data would want to provide citation of a respected source (and should have easy access to such information if they are reporting energy use for a technology they are familiar with).
5 The Stereo Receiver Energy Savings Calculator and a number of other tools are available at http://www.energystar.gov/products/. Tools of this nature are listed in Appendix C.
6 In order to come up with this kWh number, the EPA's simple calculator makes assumptions on stereo receiver use and other factors that are based on federal government research, but may or may not be applicable to every situation. Registrants should take caution using such tools, and should explain why the assumptions made in the tool are reasonable for their particular situation.

Table 3 – EPA Energy Star Stereo Receiver Energy Savings Calculator

INPUT AREA		
(Please insert the relevant figures in the input boxes)	ENERGY STAR-Labeled Unit	Non-ENERGY STAR-Labeled Unit
Number of units	1	1
Watts per unit in "off " mode*	0.5	2
** Please input this figure from the Program Compliant Products List at* [*http://yosemite1.epa.gov/estar/consumers.nsf/content/homeaudioanddvd.htm*](http://yosemite1.epa.gov/estar/consumers.nsf/content/homeaudioanddvd.htm).		
OPERATING COSTS FOR 1 STEREO RECEIVER(S) *Electricity Rate ($/kWh): 0.077 - Discount Rate (%): 4.00*		
	ENERGY STAR-Labeled Unit	Non-ENERGY STAR-Labeled Unit
Annual Operating Costs		
Energy consumption, kWh	41	54
The Stereo Receiver Energy Savings Calculator can also be used to determine operating cost savings per receiver, and other data. For this example, the most useful output from the calculator is the kWh consumption. Additional information available in both the input and output sections has been cut from this example to conserve space.		

Table 4 - Electricity Grid Emission Rates For Wisconsin

Air Emission	Emission Factor	Units
CO_2	1851	Pounds/MWh
SO_2	8.2	Pounds/MWh
NO_x	4.2	Pounds/MWh
Hg	0.034	Pounds/GWh

Table 5 summarizes Anthony's emission reductions following the same calculations and unit conversions for each air contaminant (except mercury, where the energy conversion is different).

Table 5 – Anthony's Emission Reductions

Air Emission	Emission Reduction	Units
CO_2	580	Tons
SO_2	2.6	Tons
NO_x	1.3	Tons
Hg	0.02	Pounds

Note that the mercury reduction of .02 pounds is below the threshold of one pound necessary to register, but the other emission reductions exceed their registration thresholds, so the mercury can be registered [see NR 437.03(5)(c)].

Anthony can now fill out the RIF and PIF forms and register his aggregated emission reductions for CO_2, NO_x, SO_2 and Hg.

Example 3 - Fuel Switch with Economic Growth

The Montgomery Burns Company operates a fish slurry canning operation called Lil' Lisa's in Springfield, WI. A large amount of process steam is needed to operate the massive canning machines. From 1996 to 1998, Lil' Lisa's used a coal-fired boiler to produce process steam. Local developments in the natural gas industry made the acquisition of natural gas cheaper, and Mr. Burns (the CEO of the Montgomery Burns Company) decided to switch to a natural gas boiler. In 1999, Lil' Lisa's converted to natural gas. Mr. Burns wants to register emission reductions from the voluntary fuel switch with the Wisconsin Voluntary Emission Reduction Registry.

Mr. Burns installed a natural gas boiler to replace the coal boiler, which was removed. The new boiler requires an air pollution permit from the DNR and is subject to New Source Performance Standards and possibly also to stringent emission limits designed to prevent significant deterioration of air quality. Mr. Burns agrees to comply with the stringent emission limits on the new boiler, which is designed to meet the new emission limits. Even though Lil' Lisa's is required to meet the emission limits in the permit, the emission reductions are still considered to be voluntary. This is because Mr. Burns voluntarily switched from coal to natural gas and voluntarily took the more stringent emission limits. No law required him to take these actions. Thus, Mr. Burns' air permit contains no mandatory emission limiting conditions as defined in NR 437.02(9).

Lil' Lisa's kept good fuel purchasing records, and plant engineers determined the average subbituminous coal combustion from 1996 to 1998 was 10,000 tons, with an average heat content of 10,000 btu/lb. During that time period, the cannery operated 7000 hours per year.

The coal boiler heat rate was calculated using the following equation:

$$(10{,}000 \text{ tons} * 2000 \text{ lbs} * 10{,}000 \text{ Btu}) / (1{,}000{,}000 \text{ Btu} * 7{,}000 \text{ hrs}) = 28.57 \text{ MMBtu/hr.}$$

This equation converts tons of coal to MMBtu (or one million Btu, a measure of heat input) per hour. In this case, the heat input rate is 28.57 MMBtu/hour.

In 1999, during the boiler fuel switch, Mr. Burns decided to make process modifications that required higher heat input (the fish slurry business, while relatively stable, realized a slight increase in consumer demand that was not being met). Mr. Burns had been planning these modifications for years, and they would have occurred independently of the fuel switch. His engineers calculated that the modified system now operates on 30 MMBtu/hr of primary fuel input to power their production system over the long-established 7000 hour per year work schedule at Lil' Lisa's. According to the Lil' Lisa's engineers, primary fuel energy input remained constant at 30 MMBtu/hr in years 2000 and 2001.

We know Lil' Lisa's has to produce more heat with the boiler, now at a rate of 30 MMBtu/hr. We assume that the heat content of the natural gas burned at Lil' Lisa's is 1000 Btu/ft^3. The following equation is used to determine the amount of natural gas necessary to reach the required heat input rate for a 7000-hour work year for the boiler.

$$(30\text{MMBtu/hr}*7000\text{hrs})/(1000\text{Btu/ft}^3) = 210 \text{ Million Cubic Feet of Natural Gas per year}$$

The equation takes the input heat rate of 30 Million Btus, and multiplies by hours in Lil' Lisa's work year to get an energy input total for the year, and then divides by the thermal content of the natural gas they will be purchasing. To meet their system requirements, Lil' Lisa's will have to burn 210 million cubic feet of natural gas each year in 1999, 2000, and 2001.

The next step for Mr. Burns in the registration process is to determine an appropriate baseline for his fish slurry plant. Determination of a baseline in this case is not as straightforward as in previous examples. The fuel switch from coal to natural gas occurred during a year where actual energy use increased. In this case, it is necessary to assume the energy increase would have occurred anyway (indeed, Mr. Burns had already decided to modify his production process before the fuel switch). If the fuel switch to natural gas hadn't occurred in 1999, the entire energy requirements of the system (30MMBtu/hr for 7000 hrs/yr in years 1999, 2000, and 2001) would have been provided by coal.

Mr. Burns recognizes this fact, and determines that emission reductions for each year beyond 1998 will have to be calculated separately based on actual energy use. This is done by comparing the amount of gas combusted with the amount of coal that would have been used to meet this demand.

In order to begin calculations for 1999, Mr. Burns must first determine how many tons of coal would have been burned in 1999 to produce the total amount of energy used that year. Mr. Burns' engineers had to determine how much coal would have been needed to meet the 30MMBtu heat rate over the Lil' Lisa work year (7000 hrs). The following calculation accomplishes this goal.

$$(30{,}000{,}000 \text{ Btu/hr}*7000 \text{ hrs/yr})/(10{,}000 \text{ Btu/lb} * 2000 \text{ lbs/ton}) = 10{,}500 \text{ tons}$$

Thus, 10,500 tons of coal would have been burned in 1999 if the plant had not been able to meet its needs with the 210 million cubic feet of natural gas. This calculation also holds true for years 2000 and 2001, because the heat input for each year did not change.

Next, Mr. Burns had to identify sub-bituminous coal and natural gas emission factors for his type of boiler. Fortunately, the USEPA provides technology and fuel-specific emission factors, which are summarized in Table 6.

Table 6 - Lil' Lisa's Coal and Gas Emission Factors

Air Contaminant	Coal Emission Factors (lbs/ton)[7]	Gas Emission Factors (lbs/million cubic feet)[8]
Carbon Dioxide	4,810	120,000
Sulfur Dioxide	35	0.6
Nitrogen Oxides	12	100
Mercury	0.000016	0.0000026

Now Mr. Burns' engineers simply multiplies the emission factors by the amounts of coal (10,500 tons) that would have been burned in 1999, and natural gas (210 million cubic feet) that actually was burned in 1999. The results of this calculation are illustrated below, and presented in Table 7.

Example Calculation of Coal and Natural Gas CO_2 Emission Reduction

10,500 tons coal * 4,810 lbs/ton * (1 ton/2000 lbs) = 25,252 tons CO_2

210 million ft^3 * 120,000 lbs/million ft^3 * (1 ton/2000 lbs) = 12,600 tons CO_2

25,252 tons CO_2 - 12,600 tons CO_2 = **12,652 tons CO_2 = Emission Reduction**

Table 7 - Year 1999 Emission Reduction Calculations

Air Contaminant	Baseline Emissions From Projected 1999 Subbituminous Coal Combustion (tons, except Hg)	Emissions From 1999 Natural Gas Combustion (tons, except Hg)	Registered Emission Reductions for 1999 (tons, except Hg)
Carbon Dioxide	25,252	12,600	12,652
Sulfur Dioxide	184	0.06	184
Nitrogen Oxides	63	10	52
Mercury	0.168 pounds	0.001 pounds	0.167 pounds

Note: The Mercury emission reduction is not significant enough to register alone, but the other emission reductions exceed their respective registration thresholds, so the mercury can be reported.

Now Mr. Burns is ready to fill out his RIF and PIF forms and register for years 1999, 2000, and 2001.

7 This set of coal emission factors was obtained from the U.S. Environmental Protection Agency (*Compilation of Air Pollutant Emission Factors, Volume I, Stationary, Point and Area Sources*, USEPA, AP-42, 5th edition, January 1, 1995, as revised by Supplements A to F and Update 2001). We assume the original coal boiler is a pulverized coal, dry bottom wall-fired boiler with pre-NSPS controls burning sub-bituminous coal. AP-42 emission factors for this boiler are available at: http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s01.pdf.

8 This set of natural gas emission factors was obtained from the USEPA AP-42 (see above footnote). We assume that Mr. Burns is burning his natural gas in a large wall-fired boiler (post-NSPS) with flue gas re-circulation. AP-42 emission factors for this boiler are available at: http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s04.pdf.

Lil' Lisa's is able to claim the same emission reductions for all three years because energy use did not change in each of the years. In most real world cases, this won't occur, and individual calculations similar to those for 1999 would be necessary for each year.

Example 4 - End Use Energy Efficiency

In 1998, Matt's Nev-R Fail Brake Pads Inc. replaced all of the incandescent light bulbs in their brake pad facility with highly efficient compact fluorescent light bulbs. Matt wants to register the resulting emission reductions. By examining his electric bills for 1995 through 2000, he learns the following:

Table 8 – Matt's Plant Electricity Use by Year

Year	Plant Electricity Use(kwh)
1995	3,500,000
1996	3,400,000
1997	3,600,000
1998	3,000,000
1999	2,800,000
2000	2,900,000
2001	3,000,000

It appears that the bulbs have made a difference in electricity use in his plant, but Matt also knows that his brake pad business was down a little bit in 1998 and 1999. Matt overhauled a couple of his production lines at the same time, and his process consumed more energy overall, but the efficiency per brake pad produced increased. In years 2000 and 2001 his brake pads boomed due to a new marketing campaign. All of these factors have conspired to muddy the impact of fluorescent lighting on Matt's electricity use, but he still wants to quantify the emission reductions so he can register with the Wisconsin Voluntary Emission Reduction Registry.

The first step in this process is to determine how many light bulbs were replaced, what their wattage was, and how long the lights were on per year.[9] Fortunately, Nev-R Fail keeps good records, and Matt was able to determine how many incandescent bulbs were replaced.

In 1997, The Nev-R Fail facility was lighted by 1000 60-Watt incandescent bulbs and 250 75-Watt incandescent bulbs, and operated for 4000 hours per year.[10] As shown in Figure 1, one 60 Watt bulb can be replaced by one 15-19 Watt compact fluorescent bulb to obtain the same amount of light. Likewise, one 75-Watt incandescent bulb can be replaced by one 20-25 Watt compact fluorescent bulb. Nev-R Fails' engineers followed these guidelines in 1998, and replaced the 1,000 60 Watt incandescent bulbs with 1,000 19 Watt compact fluorescent bulbs, and the 250 75 Watt incandescent bulbs with 250 25 Watt compact fluorescent bulbs.

9 We ignore light bulb installation costs and other costs for this example, and focus on light bulb energy use and efficiency impacts on emissions.
10 We assume that Nev-R Fail operates 4000 hours every year, as stipulated in their union contract.

Figure 1 – Federal Energy Management Program Light Bulb Efficiency Guide[11]

Efficiency Recommendation

To Replace Incandescent Bulb rated at:	Necessary Light Output (Lumens)	Typical CFL Replacement Wattage[a]	Recommended CFL Lumens per Watt (lpw)
Bare Bulbs[b]			
40 watts	495 or more	11 - 14 watts	45 lpw or more
60 watts	900 or more	15 - 19 watts	60 lpw or more
75 watts	1200 or more	20 - 25 watts	60 lpw or more
100 watts	1750 or more	≥ 29 watts	60 lpw or more
Reflector Type Bulbs			
50 watts	550 or more	17 - 19 watts	33 lpw or more
60 watts	675 or more	20 - 21 watts	40 lpw or more
75 watts	875 or more	≥ 22 watts	40 lpw or more

a) Some more efficient lower wattage CFLs can produce equivalent light output to the corresponding incandescents (listed in left-hand column); to assure sufficient lighting, make sure the CFL replacement provides at least enough lumens.

b) Covered bulbs have lower lumens per watt. Recommended lpw for covered lamps are as follows: ≤ 14 watts: 40 lpw; 15-19 watts: 48 lpw; 20-24 watts: 50 lpw; ≥ 25 watts: 55 lpw.

Matt's next step is to calculate energy consumed by incandescent bulbs in 1997, and the fluorescent bulbs in 1998.[12]

Incandescent Bulb Energy Use Calculation

1000 * 60 Watts * 4000 hours = 240 MWh

250 * 75 Watts * 4000 hours = 75 MWh

Total Electricity Consumption = 315 MWh

Fluorescent Bulb Energy Use Calculation

1000 * 19 Watts * 4000 hours = 76 MWh

250 * 25 Watts * 4000 hours = 25 MWh

Total Electricity Consumption = 101 MWh

11 This efficiency recommendation table is available from the Federal Energy Management Program, or FEMP, which instructs federal agencies how to make energy efficient purchases. The table and similar information is available at: http://www.eren.doe.gov/femp/procurement/pdfs/cfl.pdf

12 Bulb replacement costs are not considered, and energy use is calculated by assuming that all bulbs are on during hours of operation.

Energy Use Savings for 1998 Due to Fluorescent Bulbs

315 MWh - 101 MWh = 214 MWh = Electricity Use Reduction

In order to register emission reductions, Matt must determine the grid emissions he was able to avoid by saving 214 MWh of electricity. It is important to get quality emission factors to ensure an accurate emission reduction estimate. Matt decides to use the following Wisconsin electricity grid emission factors.

Table 9 – Electricity Grid Emission Rates For Wisconsin[13]

Air Emission	Emission Factor	Units
CO_2	1851.5	Pounds/MWh
SO_2	8.2	Pounds/MWh
NO_x	4.2	Pounds/MWh
Hg	0.0339	Pounds/GWh

Matt then uses the factors in Table 9 to determine the emissions from 214 MWh worth of grid emissions in Wisconsin. CO_2 emissions will be used to illustrate the calculations Matt had to perform in order to register.

Emission Reduction Calculations

214 MWh * 1851.5 Pounds CO_2/MWh = 396,221 pounds CO_2

396,221 pounds CO_2 * (1 ton/2000 pounds) = 198 tons = CO_2 Emission Reduction

Table 10 summarizes Matt's emission reductions following the same calculations and unit conversions for each type of emission.

Table 10 – Nev-R Fail's Emission Reductions

Air Emission	Emission Reduction	Units
CO_2	198	Tons
SO_2	0.9	Tons
NO_x	0.45	Tons
Hg	0.007	Pounds

Note that Matt's SO_2, NO_x and mercury reductions are below the registration thresholds prescribed in the registry rule, but CO_2 reductions exceed the registration threshold, so the other emissions can be registered.

13 The grid emission rates in Table B8 are from the USEPA's Emissions & Generation Resource Integrated Database (EGRID), which assembles and compiles energy data from a variety of federal sources. These emission rates are based upon 1998 data, and are available at http://www.epa.gov/airmarkets/egrid/index.html

Matt can now fill out the RIF and PIF forms and register his emission reductions for CO_2, NO_x, SO_2 and Hg for the years 1998, 1999, 2000, 2001 and 2002.[14]

Example 5 - Landfill Methane

Caroline Co., a waste management company, operates a solid waste landfill in Kenosha, WI. In 2000 the landfill contained 5.5 million tons of solid waste. In 2001, an additional 220,000 tons of solid waste was added to the landfill.

Caroline installed a landfill gas collection system in 1990, as required by Wisconsin regulations. The collection system captures almost all of the landfill gas generated. Since 1990, all of the captured landfill gas has been flared. In 2000, Caroline decided to install a boiler to burn the landfill gas to generate electricity.

Caroline's engineers have carefully measured the amount of landfill gas combusted, and they know that in 2001 her landfill will emit 23,500,000 cubic meters (or 1,500,675,000 cubic feet or 31,250 tons) of methane.[15] Caroline needs to calculate an hourly heat input rate for her captured methane so she can determine how large the new boiler must be. She first determines how many Btu are in 1,500,675,000 cubic feet of methane, and then divides this total by hours in the year. The calculation is illustrated below.

Available Heat Rate Calculation

(1,500,675,000 cubic feet of methane * 1,000 btu/ft^3) / 7000 hours = 214 MMbtu/hr

Given this average hourly heat input rate, Caroline knows how large the boiler must be to combust all of the captured methane on site to produce electricity. She installs a brand new large wall-fired boiler (post-NSPS) with flue gas re-circulation.[16] Before installing the new boiler, Caroline obtains a new source air permit from the DNR, as required by law.

Because Caroline is required by law to collect and combust the captured landfill gas, she cannot register the emissions reduced from the capture of the landfill methane. She can register the emissions avoided by producing electricity from the captured methane, which displaces electricity from the grid.

For this example, we assume that the air pollutant emissions from the boiler are identical to the emissions from the flare. We also assume that both the boiler and the flare meet the New Source

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14 We assume that in the years 1998, 1999, 2000, 2001 and 2002, the Nev-R Fail plant did not add any additional lighting or modify the electricity consumption signature of the lighting replacement that occurred in 1998. In other words, the end use energy efficiency gains first realized from the bulb switch in 1998 are the same for years 1999, 2000, 2001, etc.

15 The amount of methane emitted, based on the amount of solid waste in a landfill, can also be computed by using the USEPA's LANGEM-Landfill Gas Emissions Software, which can be downloaded at http://www.epa.gov/ttn/atw/landfill/landflpg.html (scroll down to Emission Estimation Tools).

16 We assume the boiler operates 7000 hours per year, and that the methane produced during off hours is stored and combusted during operating hours.

Performance Standards for the control of hazardous air pollutant emissions from landfills.

Caroline needs to calculate the emission reduction for the cleaner electricity produced from her landfill methane fired boiler versus the electric grid emission rate. The first step in this process is to determine how much electricity Caroline produces with her boiler. We know the heat input rate is 214 MMbtu/hr, and that the efficiency of her boiler (how much of the energy input is converted to electricity) is 36%. Given this information, we can calculate how much electricity Caroline's boiler produces per year.

214 MMbtu/hr * 7000 hrs * (1 kWh / 3413 btu) * 0.36 = 158 GWh production in one year.

In order to register her emission reductions from electricity production, Caroline must determine the grid emissions that would have resulted from the production of 158 GWh of electricity. It is important to get quality emission factors to ensure an accurate emission reduction estimate. Caroline decides to use the following Wisconsin electricity grid emission factors.

Table 11 – Electricity Grid Emission Rates For Wisconsin[17]

Air Emission	Emission Factor	Units
CO_2	1851	Pounds/MWh
SO_2	8.2	Pounds/MWh
NO_x	4.2	Pounds/MWh
Hg	.034	**Pounds/GWh**

Grid Emissions Calculation

All of the avoided electricity emissions are calculated using the following algorithm, showing the CO_2 calculation as an example. The avoided emissions are given in Table 12. All of these avoided emissions may be registered by Caroline as emission reductions.

158,000 MWh * (1851 lbs CO_2/MWh) * (1 ton / 2000 lbs) = 146,229 tons CO_2

17 The grid emission rates in Table B11 are from the USEPA's Emissions & Generation Resource Integrated Database (EGRID), which assembles and compiles energy data from a variety of federal sources. These emission rates are based upon 1998 data, and are available at http://www.epa.gov/airmarkets/egrid/index.html (**check this link**)

Table 12 - Caroline's Year 2001 Grid Emission Offset Reduction Calculations

Emission	Grid Emissions From production of 158 GWh of electricity (tons, except Hg)
Carbon Dioxide	146,229
Sulfur Dioxide	647
Nitrogen Oxides	332
Mercury	5.37 pounds

Example 6 - Reduction in Vehicle Miles Traveled

IniTech, a software developer, is based in Racine, WI in a large office building housing 400 employees. While IniTech has a large parking lot available, it wishes to reduce the total vehicle miles traveled by its employees and claim a credit for that emission reduction. To encourage its employees to seek alternative forms of transportation, such as carpooling, biking, or public transportation, IniTech decides to implement a parking fee of $3, assessed per vehicle per day starting on January 1, 2001. The fee is waived for cars with more than one passenger in order to encourage carpooling.

Before instituting the parking fee, IniTech's parking lot contained an average of 350 vehicles per day. A year after instituting the fee, IniTech determines that it has averaged 250 vehicles per day over that time period. In order to determine how many vehicle miles were saved, and the emissions reduced by 100 fewer cars per day, IniTech surveys its employees. The survey determines who no longer drives to work and how many miles per day those drivers are saving. IniTech discovers that on average, the 100 people who no longer drive to work are saving 18 miles round trip per day. This results in an average reduction of (18 x 100) = 1800 fewer vehicle miles per day which equates to an estimated 469,800 miles per year, assuming 261 working days per year.[18] The employee survey also determines that 50 percent of the saved miles would have occurred on city streets, with the other 50 percent saved from freeway driving, two percent of which occurs on freeway ramps. The number of VMT saved for each type of driving is given in Table 13.

Table 13 - VMT Reduced in 2001	
Total Miles Saved	469,800
City/Local Road Miles Saved	234,900
Freeway Miles Saved	230,202
Freeway Ramp Miles Saved	4,698

18 The 261 days represents the number of workdays at IniTech, equal to 365 days of the year less 104 weekend days.

IniTech then calculates avoided emissions using emission factors from the USEPA's MOBILE5 Model.[19] The emission factors, VMT reduced, and emissions saved by roadway type are presented in Table 14. The equation used to determine emissions reduced for each type of driving is:

Emissions Reduced = (miles saved) x (emission factor).

Table 14 - Emissions Reduced in 2001

Air Contaminant	Local Road Emission Factor (g/mi)	Local Road Emissions Reduced (grams)	Freeway Emission Factor (g/mi)	Freeway Emissions Reduced (grams)	Freeway Ramp Emission Factor (g/mi)	Freeway Ramp Emissions Reduced (grams)	Total Emissions Reduced (grams)
VOC	1.298	304,900	0.764	175,874	0.989	4,646	485,420
NOx	1.518	356,578	2.631	605,661	1.998	9,387	971,626
Carbon Monoxide	8.659	2,033,999	13.076	3,010,121	17.298	81,266	5,125,386

IniTech then converts the total emissions reduced into tons.

Table 15 - Conversion of Emissions Reduced

Air Contaminant	Emissions Reduced (grams)	Emissions Reduced (tons)
VOC	485,420	0.53
NOx	971,626	1.07
CO	5,125,386	5.64

To determine the amount of CO_2 emissions reduced, IniTech must determine how many gallons of gasoline were saved. IniTech assumes that the average fuel economy of a car is 20.4 miles per gallon.[20] A VMT reduction of 469,800 miles equals 23,029 gallons of gasoline saved. IniTech calculates the amount of CO_2 reduced as follows:

130,000 Btu per gallon of gasoline = 0.13 million Btu (MMBtu) per gallon

(0.13 MMBtu per gallon) x (0.99)[21] x (153.3 lbs. CO_2 per MMBtu) [22]

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19 The USEPA MOBILE5 model is available at http://www.epa.gov/otaq/m6.htm. IniTech must make a number of assumptions about the levels of driving, average speeds driven, ambient temperatures in the area, and other factors that are accounted for in MOBILE5. IniTech estimates an average freeway speed of 57.5 mph, 2 percent of freeway miles are driven on ramps, and temperatures of 70 to 94 degrees.

20 Average miles per gallon of light duty vehicles in the US is available from: http://www.epa.gov/otaq/cert/mpg/fetrends/s01001.pdf

21 The average combustion efficiency factor is from the USEPA *States Workbook: Methodologies For Estimating Greenhouse Gas Emissions*, November 1992, p. 1-3. The 0.99 factor is the carbon combustion efficiency and assumes that 99% of the carbon in the fuel is converted to CO_2. Some of the carbon in the gasoline becomes CO and VOCs.

22 The emission factor used in this example is from the USEPA *State Workbook: Methodologies For Estimating Greenhouse Gas Emissions*, November 1992, p. 1-3.

= 19.73 lbs CO_2 emitted per gallon of gasoline burned

(23,029 gallons of gasoline saved) x (19.73 lbs CO_2 per gallon) = 454,362 lbs. CO_2 reduced = 227 tons of CO_2 reduced.

The amount of carbon dioxide reduced is over the 25 ton registration threshold in Table 1 in the registry rule, and the carbon monoxide and NOx reductions are over their respective thresholds. Therefore, IniTech can register the VOC emission reduction, even though it is not over the VOC threshold.

With this information, IniTech can now fill out the RIF and PIF forms for their emission reductions.

Example 7 - Recycling

Erica's Engineering Company (EEC) designs and manufactures sculptures and odd lawn ornaments. Prior to 2001, the possible environmental and economic benefits of recycling and source reduction were largely ignored at EEC. With the recent economic downtrend, Erica, the CEO of EEC, had to look for ways to cut costs in order to remain profitable in the long run. Erica knows that source reduction and recycling can reduce her waste stream and up front material costs, so she decided to implement a company-wide recycling and source reduction program.

Source reduction is emphasized for office paper, packaging, and the lawn ornament production process. Reduction in the use of office paper through employee training, education, and better use of advanced information management systems (EEC purchased such a system two years ago that nobody seems to know how to use properly) promises large gains in resource efficiency. Redesigned packaging for her products that use less plastic and cardboard can save thousands of dollars in up front material costs while benefiting the environment. Erica also reconfigured her computer controlled production systems to use raw materials (primarily steel and iron, depending upon the lawn ornament being produced) more efficiently, reducing the inputs to her system while producing the same output.

In addition to source reduction activities, Erica identified areas where recycling is feasible. Around the offices and at the plant, EEC began collecting newspaper, office paper, old phone books, aluminum cans, scrap process steel, HPDE and LDPE Plastics, and glass containers. Through her recycling activities, Erica is able to significantly reduce EEC's raw material input stream (when materials could be reused) and waste output streams, saving money on the front and back ends. [23] She wants to claim credit for her actions in the Wisconsin Voluntary Emission Reduction Registry.

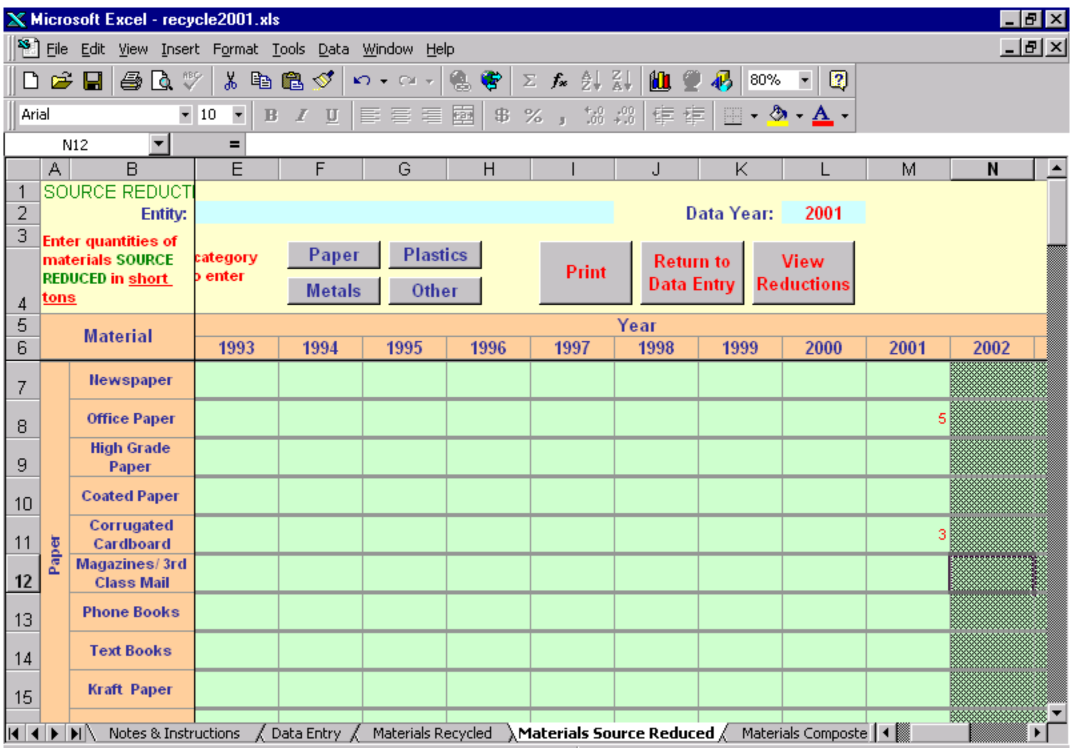
In order to claim her emission reductions, Erica must determine the volume of material that is reduced or recycled as a result of the EEC program. After studying input and output material flows for 2001, following introduction of the recycling program, Erica calculated that her company reduced 5 tons of

23 In the recycling example, we assume that Erica could reuse some of the recycled materials within the plant, and that the state or municipality where she is located operates a recycling program. Detailed analysis of the cost of recycling (and levels of reuse) would be necessary to determine the profitability of individual recycling programs, but we will assume Erica's recycling program is feasible in the long run (cost is neutral, or offset by positive PR, etc.).

office paper, 3 tons of corrugated cardboard, 10 tons of HDPE plastic, 10 tons of steel, and 5 tons of iron.[24] Erica also determined her company recycled 3 tons of newspaper, 5 tons of office paper, 1 ton of phone books, 4 tons of aluminum cans, 5 tons of scrap steel, 1 ton of HDPE plastic, 1 ton of LDPE plastic, and 3 tons of glass containers.

Erica now knows how much of each material was reduced or recycled, but she is confused about how to calculate emission reductions from the data available to her. Fortunately, the USEPA and the US Department of Energy recognize the difficulty of such calculations, and provide an excellent Microsoft® Excel-based recycling tool.[25] All Erica needs to do is plug her source reduction or recycling data into the appropriate cells in the Excel tool, and her emission reductions will be automatically calculated using EPA approved emission factors. A snapshot of Erica's input frame for source reduced paper is provided in Figure 2 below.

Figure 2 - Erica's Input Frame for Source Reduced Paper

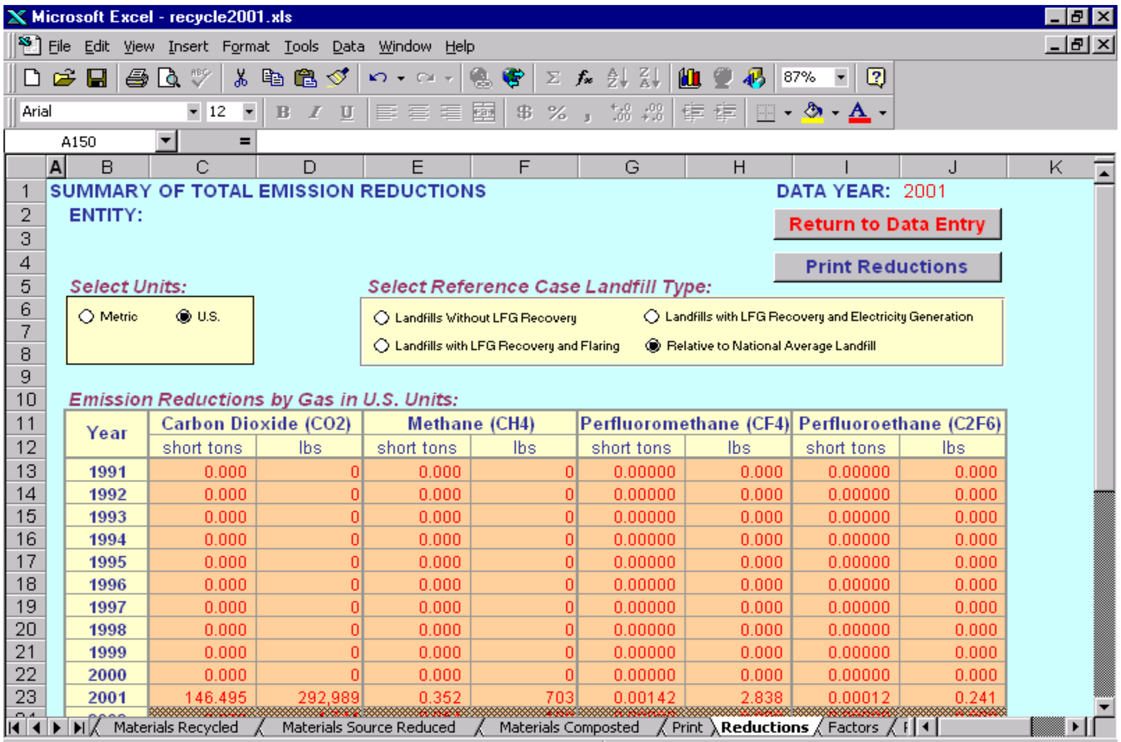


24 We will not get into the details about how Erica determined the amount of materials source reduced or recycled. Depending upon the scale of operations, very detailed studies may be necessary, but more than likely, a brief analysis of purchase orders versus final output will provide enough information to determine volume of material source reduced through different actions. In the case of recycling, Erica probably just had the recyclable materials weighed to determine how much of each was recycled.

25 The EIA 1605 Recycling, Source Reduction and Composting Excel Workbook is available for download at http://www.eia.doe.gov/oiaf/1605/techassist.html. Once the tool is downloaded to a computer, it allows the user to input amounts of materials source reduced and recycled and automatically calculates emission reductions using EPA accepted emission factors.

A snapshot of Erica's output frame showing the calculated emission reductions is provided in Figure 3.

Figure 3 - Calculated Emission Reductions for Source Reduced Paper



Year	Carbon Dioxide (CO2)		Methane (CH4)		Perfluoromethane (CF4)		Perfluoroethane (C2F6)	
	short tons	lbs	short tons	lbs	short tons	lbs	short tons	lbs
1991	0.000	0	0.000	0	0.00000	0.000	0.00000	0.000
1992	0.000	0	0.000	0	0.00000	0.000	0.00000	0.000
1993	0.000	0	0.000	0	0.00000	0.000	0.00000	0.000
1994	0.000	0	0.000	0	0.00000	0.000	0.00000	0.000
1995	0.000	0	0.000	0	0.00000	0.000	0.00000	0.000
1996	0.000	0	0.000	0	0.00000	0.000	0.00000	0.000
1997	0.000	0	0.000	0	0.00000	0.000	0.00000	0.000
1998	0.000	0	0.000	0	0.00000	0.000	0.00000	0.000
1999	0.000	0	0.000	0	0.00000	0.000	0.00000	0.000
2000	0.000	0	0.000	0	0.00000	0.000	0.00000	0.000
2001	146.495	292,989	0.352	703	0.00142	2.838	0.00012	0.241

Next, Erica must convert the greenhouse gas emission reductions in Figure 3 into CO_2 equivalents, as required by the registry rule [NR 437.06(2)]. This is done using the global warming potentials for the various non-CO_2 greenhouse gases as shown in the calculations below. The calculated CO_2 equivalent reductions are then added to the CO_2 reductions to obtain the total greenhouse gas reduction.

Global Warming Potential (GWP) Calculations[26]

0.352 tons CH_4 * 23 (IPCC GWP value for CH_4) = 8.1 tons CO_2-equivalent

0.00142 tons CF_4 * 5,700 (IPCC GWP value for CF_4) = 8.1 tons CO_2-equivalent

0.00012 tons C_2F_6 * 11,900 (IPCC GWP value for C_2F_6) = 1.4 tons CO_2-equivalent

Calculation of Total Greenhouse Gas Emission Reductions in Carbon Dioxide Equivalents

146.5 tons + 8.1 tons + 8.1 tons + 1.4 tons = 164.1 tons CO_2-equivalent

26 The global warming potentials used in this example are from the Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report and are given in Appendix D.

Erica's total greenhouse gas emission reduction of 164 tons is greater than the registration threshold of 25 tons in Table 1 in the registry rule, so Erica can register an emission reduction of 164 tons of CO_2 when she fills out her RIF and PIF forms.

Example 8 - Industrial Process Change – Asphalt

Snoop's Paving Co. paves residential driveways in suburban Milwaukee. Snoop Dawg, the company's proprietor, uses rapid cure (RC) cutback asphalt to pave driveways for his customers. RC cutback asphalt, which is produced by blending asphalt cement with naptha and gasoline solvents, emits a significant amount of VOCs as it cures . The VOC emissions occur as a result of the asphalt diluent evaporating during both the asphalt production process and at the job site.

The use of RC cutback asphalt is prohibited during the ozone season (May through September) in Wisconsin (see NR 422.16, Wis. Adm. Code). Because his business must comply with the regulation and Snoop has tried to establish green practices in his business, he decides to switch the type of asphalt he uses for his driveways to emulsified asphalt. Emulsified asphalt emits very small amounts of VOC.

In order to determine what level of VOC emissions Snoop saved during 2001 (or any year), he first calculates a two-year average emission baseline, and then calculates his emissions after switching to emulsified asphalt. His emission reduction will be the difference in the baseline and the reduced emissions.

Looking back at records for 1999 and 2000, Snoop determines that he used 1100 tons of RC cutback asphalt in 1999 and 900 tons of RC cutback asphalt in 2000. Averaging 900 tons and 1100 tons, Snoop's two-year average baseline is 1,000 tons/year.

To determine what level of VOCs would have been emitted by 1,000 tons of cutback asphalt, Snoop refers to the USEPA's AP-42 document on asphalt paving operations.[27] Snoop knows that the RC cutback asphalt he used contained 45% diluent by volume. Using AP-42 (*Compilation of Air Pollutant Emission Factors*, USEPA), Snoop sees that for RC cutback asphalt with 45% diluent the emission factor is 32%. This means that 32% by weight of the asphalt evaporates into the air.

1,000 tons of RC cutback asphalt x 0.32 = 320 tons of VOC per year

Now, Snoop needs to calculate how much VOC his business emitted in 2001. Looking back at his records, Snoop discovers that he used 1050 tons of emulsified asphalt. Consulting again with AP-42 and the product information for the emulsified asphalt, Snoop calculates that the emulsified asphalt emits 4% VOC by weight.

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27 USEPA AP-42 (*Compilation of Air Pollutant Emission Factors, Volume 1: Stationary, Point, and Area Sources,* USEPA, AP-42, 5th edition, January 1, 1995, as revised by Supplements A to F and Update 2001). Emission factors for asphalt paving operations are available at http://www.epa.gov/ttn/chief/ap42/ch04/final/c4s05.pdf

1050 tons of emulsified asphalt x 0.04 = 42 tons of VOC in 2001.

Subtracting the reduced emissions from the baseline emissions:

320 Tons per year VOC emitted (baseline) - 42 Tons VOC in 2001 = 278 Tons VOC reduced in 2001.

Snoop's Paving Company is located within the southeastern Wisconsin ozone non-attainment area. Snoop does 80% of his business during the five-month ozone season, which runs from May through September. Snoop cannot register his VOC reductions which occur during the ozone season, because the use of cutback asphalt is prohibited during the ozone season and he was required by law to use emulsified asphalt during the ozone season. But, Snoop can register the emission reductions which occur outside the ozone season, since he uses emulsified asphalt all year.

Snoop calculates the VOC emission reduction he is eligible to register as follows:

278 tons * .20 = 56 tons VOC reduced outside the ozone season

Snoop is now ready to fill out the RIF and PIF forms to register his emission reduction. In future years, Snoop considers offering a discount for customers who pave their driveways outside of the five-month Ozone season. That way his business is helping to decrease volatile organic compounds during the ozone season.

Example 9 - Carbon Sequestration through Prairie Restoration

Farmer Patrick has been growing corn and soybeans for a number of years on his 200-acre farm in Dane County. He is now interested in returning some of his land to native vegetation to help combat erosion, improve water quality, provide wildlife habitat and aesthetic value, and to sequester carbon. Farmer Patrick wants to convert 10% of his land, or 20 acres, to native grasses, and wants to know how to measure the carbon that his land will be sequestering from the atmosphere over time. [28]

Farmer Patrick knows that he must establish a baseline of carbon sequestration for his land under the current "business-as-usual" case for his cropping systems, then compare this value with the carbon content in his soil after several years under the new, restored grass cover. He knows that estimating carbon sequestration in ecosystems is a relatively new technique, so methods are still being standardized, and there is not a uniform standard protocol. For the time being, he consults with experts at UW-Madison and the DNR, and makes some reasonable assumptions for his case.

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28 The carbon cycle in an ecosystem begins with plants "fixing" atmospheric carbon (in the form of CO_2) through the process of photosynthesis. When the plants die, some of their organic (carbon-based) matter, such as leaves, stems, roots, etc. enters the soil through decomposition by microorganisms such as bacteria and fungi, which break down plant matter into other forms of carbon. Carbon may be chemically or physically stabilized in the soil for varying amounts of time depending on conditions such as climate, soil type, and litter input.

Developing Baseline Carbon Storage

For this case, the baseline carbon storage is the amount of carbon in the top 3 feet (1 m) of the soil before the prairie restoration begins. It is assumed that below that depth, organic matter input from plants is insignificant so carbon storage is low. (In some cases, the depth of interest may be larger or smaller depending on soil depth before hitting bedrock.) It is also assumed that restoring Farmer Patrick's agricultural lands to native grasses will improve carbon storage through the addition of organic matter and root turnover, and the lack of soil disturbances such as plowing.

The baseline carbon storage must be estimated for both a representative crop system and the land to be restored as grassland. This will be done initially just *before* restoration, when both land use scenarios are the same, then the same areas will be measured five years later to determine net carbon storage changes by comparing the agricultural system with the restored one. The initial measurement ideally should be taken before management changes are undertaken.

Soil carbon concentration tends to decrease exponentially with depth (similar to rooting depth), so Farmer Patrick expects the most carbon to be stored near the surface, where the input of plant litter and the concentration of microorganisms to break down that litter to long-term stable forms are highest. However, soil carbon content can change rapidly with depth, so it is important to have shallower sampling layers near the surface so that changes in soil carbon can be more readily detected between different land use practices.

Five samples are taken in both the cropland and the area that will be restored (see Figure 4). Because soil carbon storage can vary significantly across small distances due to slope, aspect, and the underlying soil type, sampling points between different land uses must be chosen to minimize these potential differences. Soil samples are taken using a 10 cm (4 inch) manual auger. Sampling is done to stratify the soil in different layers (i.e., 0-5 cm, 5-10 cm, 10-20 cm, 20-30cm, 30-40cm, and 40-50cm). One composite sample consists of the soil from several cores mixed at each layer (i.e., take 3 cores within a 1 square meter sampling square and mix together the soil from the 0-5 cm layer for all three cores, mix the soil from the 5-10cm layer from all 3 cores, etc.). (See) Mixing several cores to form one composite sample per small sampling square reduces the sample variability and gives a better idea of the true average soil carbon sequestration. Five additional intact soil cores of known volume are also taken to derive the soil bulk density (mass of dry soil per volume).

These composite samples are dried in ovens at 70° C for 48 hours and are ground with a mortar and pestle to pass through a 100 μm sieve. A small subsample (e.g., 5 g) is sent to a soil and plant lab for analysis. The percentage of soil mass stored as soil carbon is determined through combustion and analysis on a gas chromatograph. The soil bulk density measurements are used to convert percent carbon to a ratio of mass of carbon per unit area, based on the known volume of the soil sample.

Carbon Storage as a Result of Management Practices

Because carbon accumulates slowly in soils from land management changes, Farmer Patrick should wait several years after baseline sampling to re-sample the same sites using the same methods to actually determine soil carbon changes resulting from land use management changes. An appropriate interval for measuring soil carbon accumulation would depend on a number of factors, but might be on the order of every 5 years. Sampling should be undertaken as close as possible to the same areas where the baselines were measured. These locations can generally be marked with wooden posts, flagging, and a hand-held Global Positioning System (GPS) for future reference. Returning to similar locations rather than sampling in a random fashion is essential to reduce measurement errors.

<u>Calculating Carbon Sequestration</u>

Once Farmer Patrick determines his baseline carbon storage and his carbon storage several years later as a result of his prairie restoration, he is ready to calculate the amount of net carbon sequestration on his land as a result of his prairie restoration, and the voluntary emission reduction that he is eligible for under the Wisconsin Voluntary Emission Reduction Registry. The following relationship is used to determine sequestration:

Carbon sequestration = altered carbon storage as a result of management practice - baseline carbon storage (units in grams of carbon per square meter of ground area)

The lab analyses provide the following results for the soil carbon content in Farmer Patrick's land.

Table 16 - Baseline carbon storage (before restoration) (units in kg/m^2)

Depth (cm)	Crop	Area to be restored as a prairie
0-5	1.3 □ 0.1	1.2 □ 0.1
5-10	1.2	1.2
10-20	1.8	1.7
20-30	1.1	1.2
30-40	0.8	0.7
40-50	0.5	0.7
TOTAL	**6.7**	**6.7**

Table 17 - Carbon storage 5 years after restoration (kg C/m^2)

Depth (cm)	Crop	Area restored as prairie
0-5	1.2	1.8
5-10	1.1	1.7
10-20	1.7	2.0
20-30	1.1	1.3
30-40	0.8	0.8
40-50	0.5	0.8
TOTAL	**6.4**	**8.4**

NET C SEQUESTRATION (soil C storage at 5 years past management change minus baseline soil C storage)		
	-0/3	**+1.7 (kg/m^2/5 years)**

To calculate his net sequestration, Farmer Patrick adds up the total carbon storage for each land cover type over all the measured soil layers. For the initial baseline, the carbon storage in the crop and area to be restored are the same, 6.7 kg/m^2. Following restoration, the soil beneath the prairie restoration was storing 8.4 kg/m^2 of carbon, compared with 6.4 g/m^2 of carbon in the cropland.

He notes that the carbon content of his crop soil decreased slightly, potentially due to the removal of plant matter and the soil disturbance from plowing, tilling etc. in this plot, which decreases the amount of organic matter available to enter the soil and the likelihood that the carbon can be stabilized in the soil. It is also possible that poor climate conditions (and subsequently poor crop growth) may have led to a decrease in the soil organic matter over the 5 years in the cropping system. He was pleased to note that, following the establishment of native grasses with their soil-holding root structure and the lack of soil disturbance, carbon storage in the restored prairie increased from its baseline five years earlier.

In this particular case, Farmer Patrick can register based on the total amount of carbon sequestered in the restored ecosystem. In addition, he can include the carbon loss that was "avoided" (e.g., business-as-usual cropping system) as a result of the land cover/management change. The difference of these two values is the "net carbon gain" that should be applicable to this project. In some cases, croplands may also sequester soil carbon over time due to better management options (i.e., reduced tillage), so that the carbon sequestered through the land management change to grasses may be slightly less than the change in soil carbon detected in the prairie system.

In this case, over the 5 year period, the crop system lost 0.3 kg C/m^2 over 5 years, or –0.06 kg C/m^2 /yr. By contrast, the prairie restoration gained 1.7 kg C/ m^2 in the 5 years, or +0.34 kg C/m^2 /yr. Thus, the "net" carbon sequestered is +0.40 kg C m^2 /yr (0.34 kg C/m^2/yr gain + 0.06 kg C/m^2/yr loss avoided) because he avoided a loss that would have resulted due to the business-as-usual crop system, and sequestered additional carbon due to the land management change to prairie.

To find the total amount of carbon sequestered for his 20 acres of restored prairie, Farmer Patrick used the annual rate of net carbon gain (+0.40 kg C/m^2) as a result of his restoration. He then multiplied it by the area of his restoration, and by the number of years of his management that resulted in the sequestered carbon.

Total carbon sequestered

= net carbon gain per year per unit area x years of management x total property area

= 0.40 kg C/m^2/year x 5 years management x 4046.9 m^2/acre x 20 acres restored

= 161, 876 kg of carbon sequestered on 20 acres over 5 years.

To convert this number to short tons,

161,876 kg C x 1 pound/0.4536 kg x 1 short ton/2000 pounds

= 178.4 short tons of carbon sequestered on 20 acres over 5 years

= 35.7 tons of carbon sequestered per year.

The carbon sequestered must be registered as carbon dioxide. To convert carbon to CO_2, the amount of carbon is multiplied by the ratio of the mass of CO_2 to the mass of carbon.

(35.7 tons of carbon) x 44/12 = 131 tons of CO_2

This estimate seems to be a reasonable one based on Farmer Patrick's information. As the technique for estimating carbon credits for sequestration projects grows, he might be able to use averages that are developed for his particular type of soil and plant mix, climate, etc. Until these are developed, though, he has a very good estimate for the carbon sequestered as a result of his management practices.

Since Farmer Patrick's sequestered carbon is greater than the registration threshold in Table 1 in the registry rule, he may register the carbon dioxide sequestered each year by filling out and submitting the application forms (RIF and PIF). He can register the sequestration for all five years by submitting only one application.

Figure 4 - A large cornfield (not to scale) with five 1x1m sampling squares. Each small square contains three sampling sites for auger holes.

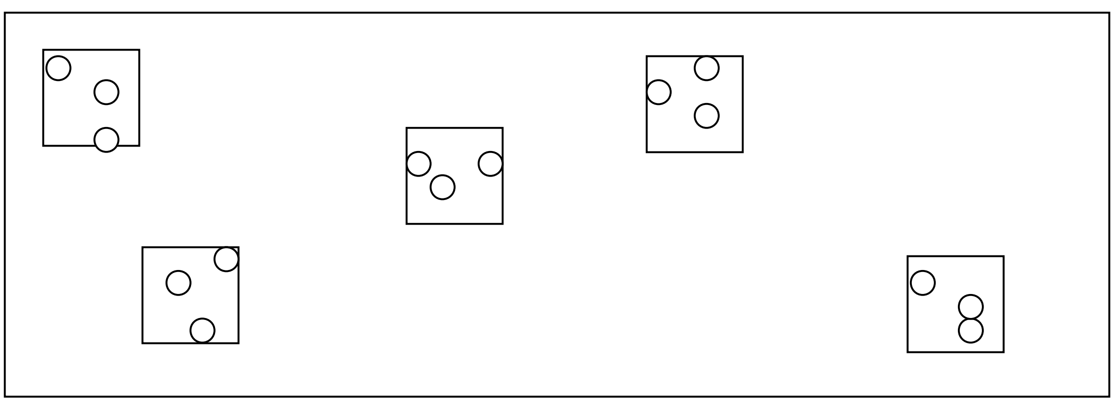
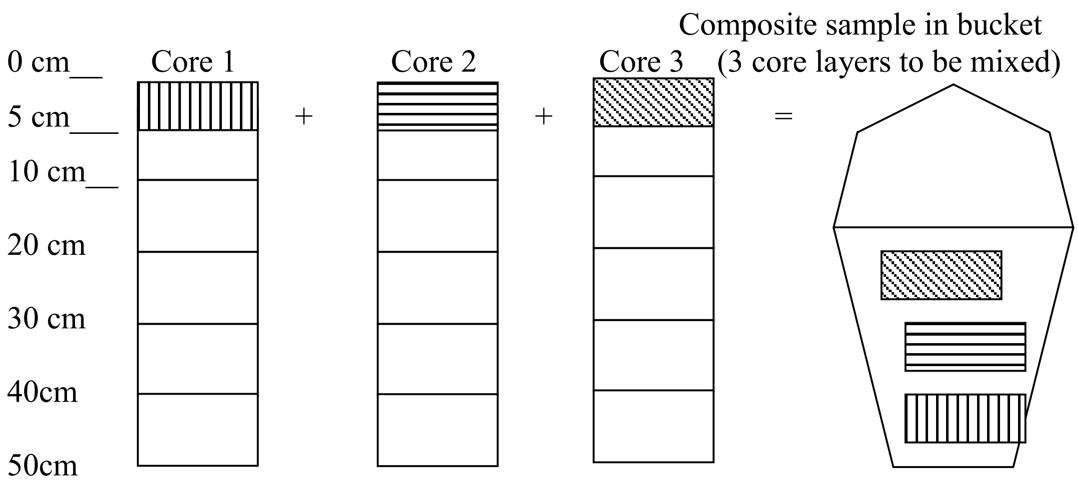


Figure 5 - Three cores from one of the 1x1 small sampling squares in Figure 1, showing how the same layers from individual cores are mixed to produce one composite sample for each small square. This would be repeated for each of the 6 layers in the three cores.



Example 10 - Carbon Sequestration through Urban Reforestation

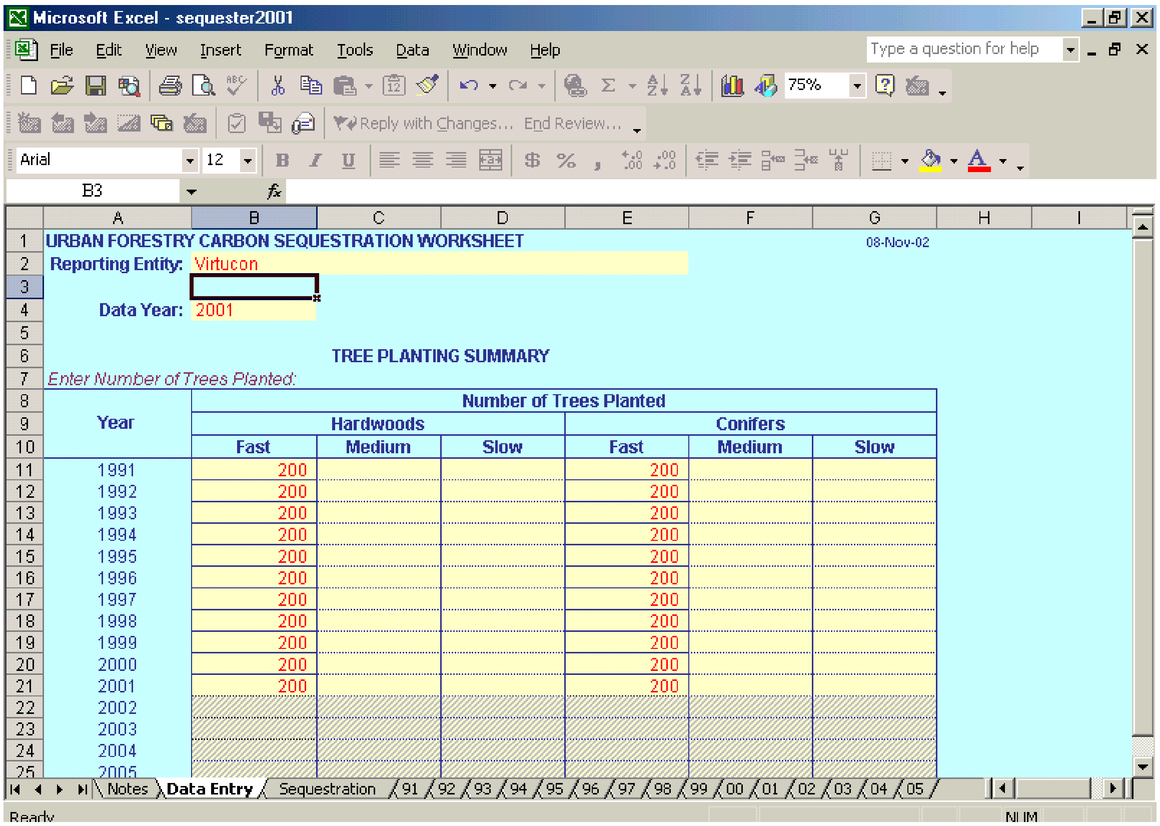
Virtucon produces high-density electronically addressable memory chips in a large corporate campus in Milwaukee. In 1991, as part of an effort to address environmental concerns, Virtucon adopted a voluntary urban forestry carbon sequestration program within and around the company's facilities in Milwaukee. Andy, Virtucon's CEO, knows that community service activities help Virtucon's image around its headquarters location.

From 1991 to 2001, Virtucon planted 200 Red Pines (a fast-growing coniferous tree), and 200 black walnuts (a fast growing hardwood) each year. Andy's wife likes these particular trees, so the number and species planted have remained the same over time. The trees are purchased from a local nursery, and are planted individually, not in groups. Virtucon's urban forestry program works public relations wonders with the local population and media, and serves as a model for other companies interested in urban carbon sequestration.

Virtucon can register emission reductions and garner additional publicity by participating in the Wisconsin Voluntary Emission Reduction Registry. Andy realizes the potential benefits, and decides to register, but is unsure how to quantify emission reductions from the trees Virtucon has planted, some over a decade ago. Fortunately, the United States Department of Energy (DOE) recognizes the difficulty of performing urban carbon sequestration calculations, and has created an excellent Excel based tool, called the Urban Forestry Carbon Sequestration Workbook, to assist registrants[29].

With the workbook, all Andy has to do is enter the number and type of trees planted by year, as illustrated in Figure 6.

Figure 6 - The Urban Forestry Carbon Sequestration Workbook Data Entry Page



URBAN FORESTRY CARBON SEQUESTRATION WORKSHEET 08-Nov-02

Reporting Entity: Virtucon

Data Year: 2001

TREE PLANTING SUMMARY

Enter Number of Trees Planted:

Year	Number of Trees Planted					
	Hardwoods			Conifers		
	Fast	Medium	Slow	Fast	Medium	Slow
1991	200			200		
1992	200			200		
1993	200			200		
1994	200			200		
1995	200			200		
1996	200			200		
1997	200			200		
1998	200			200		
1999	200			200		
2000	200			200		
2001	200			200		
2002						
2003						
2004						
2005						

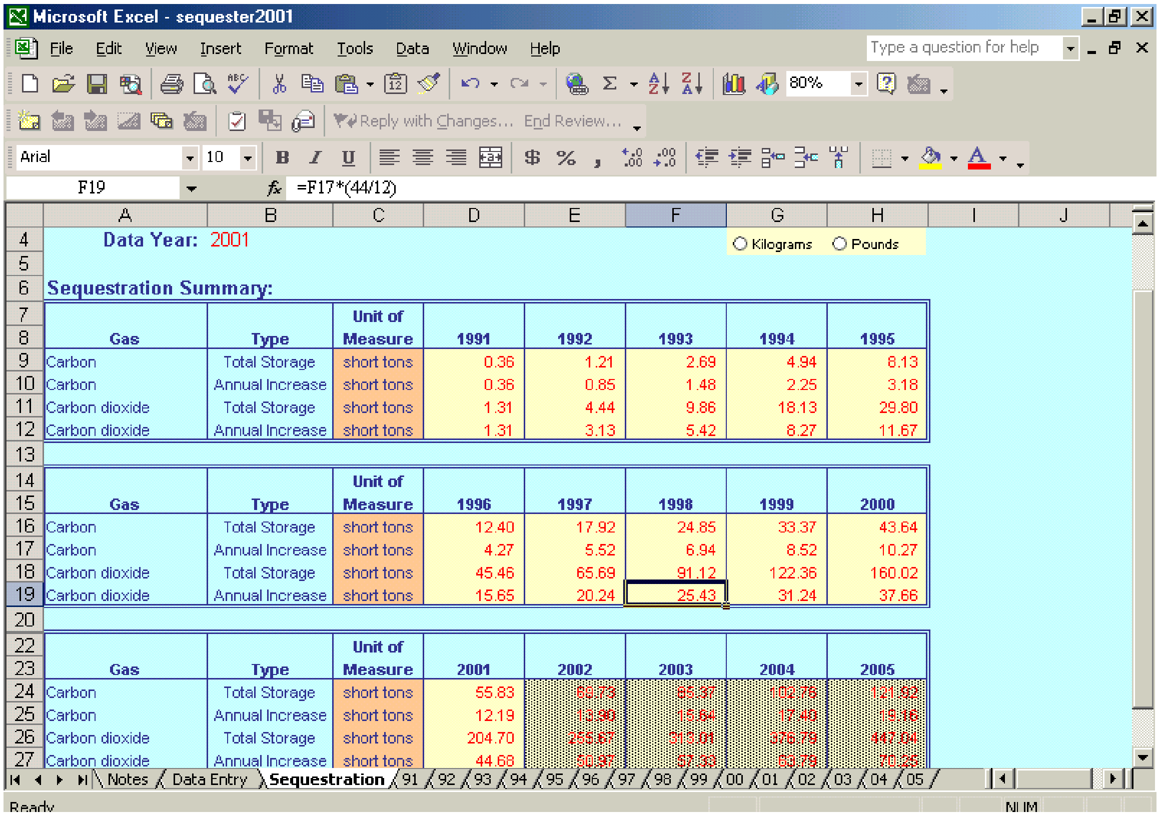
After Andy enters all of the necessary data, he takes a look at the sequestration page within the Excel tool to determine the amount of carbon sequestered over the years. The workbook output is available in

Figure 7.

Andy knows that he cannot register emission reductions unless the amount of carbon dioxide sequestered is greater than 25 tons in any given year, according to the registration thresholds in the Wisconsin Emission Reduction Registry Regulations (NR 437, Table 1).

29 The Urban Forestry Carbon Sequestration Workbook can be downloaded at http://www.eia.doe.gov/oiaf/1605/techassist.html. An accompanying PDF file helps registrants identify necessary tree input parameters such as growth rate. Andy, for example, had no idea if a black walnut was a hardwood or coniferous, let alone how quickly it grows. The Urban Forestry Carbon Sequestration Handbook PDF helped Andy identify the characteristics of the trees he planted so the workbook output is as accurate as possible.

Figure 7 - The Urban Forestry Carbon Sequestration Workbook Results Page


Microsoft Excel - sequester2001

Data Year: 2001

Kilograms Pounds

Sequestration Summary:

Gas	Type	Unit of Measure	1991	1992	1993	1994	1995
Carbon	Total Storage	short tons	0.36	1.21	2.69	4.94	8.13
Carbon	Annual Increase	short tons	0.36	0.85	1.48	2.25	3.18
Carbon dioxide	Total Storage	short tons	1.31	4.44	9.86	18.13	29.80
Carbon dioxide	Annual Increase	short tons	1.31	3.13	5.42	8.27	11.67

Gas	Type	Unit of Measure	1996	1997	1998	1999	2000
Carbon	Total Storage	short tons	12.40	17.92	24.85	33.37	43.64
Carbon	Annual Increase	short tons	4.27	5.52	6.94	8.52	10.27
Carbon dioxide	Total Storage	short tons	45.46	65.69	91.12	122.36	160.02
Carbon dioxide	Annual Increase	short tons	15.65	20.24	25.43	31.24	37.66

Gas	Type	Unit of Measure	2001	2002	2003	2004	2005
Carbon	Total Storage	short tons	55.83	69.73	85.37	102.76	121.92
Carbon	Annual Increase	short tons	12.19	13.90	15.64	17.40	19.16
Carbon dioxide	Total Storage	short tons	204.70	255.67	313.01	376.79	447.04
Carbon dioxide	Annual Increase	short tons	44.68	50.97	57.33	63.79	70.25

Fortunately, the Carbon Sequestration Worksheet has a field called "Annual Increase" that calculates the carbon sequestered each year. As evident in the workbook output, the annual increase, or total carbon sequestered in any one given year does not exceed the registration threshold until 1998, when 25.43 tons of carbon dioxide are sequestered by the whole population of trees planted from 1991 until 1998.

The Carbon Sequestration Worksheet uses many assumptions, including tree carbon sequestration rates (these change over time depending upon the type and age of trees), and survival rates over time (these also vary depending upon type and age of trees). The important thing to remember is that the tool displays total carbon sequestered (aggregated over all the years since the first tree was planted, available in the "Total Storage" field), *and* individual year carbon sequestered (this is the "Annual Increase" field). The individual year amount employs varying growth rates and survival rates for any population of up to six different categories of trees. A tree planted in 1991 would be 11 years old in 2002, and would have different carbon sequestration and survival rates than a tree of the same species planted in 2000. The key fact to remember is that both of the trees (the 11 year old and 2 year old) are actively sequestering carbon in 2002, and the DOE workbook provides a simple mechanism to calculate emission reductions that account for tree classification, age, and growth rate.

The Urban Carbon Sequestration tool only calculates direct carbon sequestration from tree growth. Other benefits of urban sequestration are not measured, and include possibly significant reductions in cooling and heating needs by providing shade in summer and wind blocks in winter. These contributions of sequestration are tough to measure in terms of emission reductions, but the benefits are very real.

Although the Wisconsin Emission Reduction Registry does not explicitly allow aggregation over multiple years, Andy knows the WDNR recognizes the ongoing nature of sequestration activities. Although trees planted in 1991 technically do not qualify as an action taken in 1998, the process of trees planted in 1991 sucking up carbon dioxide in 1998 can be viewed as an action in that year. In other words, sequestration is an ongoing activity, and the sequestration contribution of a tree planted in 1991 can be counted in 1998, if it can be accurately measured.

Andy can now fill out his RIF and PIF forms, and register emission reductions of 25.43 tons in 1998, 31.24 tons in 1999, 37.66 tons in 2000, and 44.68 tons in 2001.

Example 11 - Air Pollution Control Permit

Corneel runs an auto body repair shop in the ozone non-attainment area of southeast Wisconsin. Volatile Organic Compounds, or VOCs, contribute to the formation of ground level ozone. Due to the detrimental effect of VOCs, the state of Wisconsin developed a series of industry sector-specific VOC emission standards, called Reasonably Available Control Technology (RACT). Part of Corneel's business involves motor vehicle refinishing (ie. sealing and repainting), which is one of the industry sectors identified and regulated by the Wisconsin Department of Natural Resources (DNR) under RACT. Corneel has been regulated by the State of Wisconsin's Motor Vehicle Refinishing RACT since 1997.[30] The RACT emission limits are specified in Corneel's air pollution control permit.

Corneel, an environmentally conscious businessman, realizes that his process contributes to public health problems, so he makes a concerted effort to minimize VOC emissions from his shop. Every year, Corneel cleans up his motor vehicle refinishing operation well beyond the levels required in the RACT[31] limits specified in the air permit, and he wants to claim credit for the emission reductions he has achieved.

First, Corneel must know exactly how his motor vehicle refinishing process works, what materials go into the process along the way, and some basic characteristics of those materials. Motor vehicle refinishing, as operated by Corneel, consists of three general steps; pretreatment, priming, and painting (possibly several applications of each, depending upon desired results). Each of these steps uses

30 Corneel's refinishing operation uses more than the 20 gallons necessary to trigger the RACT requirement, but his business is not large enough to trigger the more complex Title V major source permit program.

31 The Wisconsin Motor Vehicle Refinishing RACT includes a notification requirement (which Corneel would have done in 1997), emission limits (which are detailed in this example), equipment standards (which Corneel would have had to meet in 1997) and recordkeeping requirements. This example only deals with the VOC content of the car coatings.

chemicals with varying amounts of VOCs to achieve the desired effect.[32] Following a detailed analysis of the typical VOC content of various coating categories, the DNR established a RACT rule that set allowable VOC content for each category at the levels in Table 18, below. Corneel has met and exceeded these standards since 1997.

Table 18 - Corneel's 1997 Coating VOC Content Compared to RACT Limit[33]

Coating Category	Maximum Coating VOC Content Allowed
Pretreatment coat	0.78 kg/liters or 6.5 lbs/gal
Precoat	0.66 kg/liters or 5.5 lbs/gal
Primer/primer surface	0.58 kg/liters or 4.8 lbs/gal
Primer sealer	0.55 kg/liters or 4.6 lbs/gal
Topcoat or base-coat/ clear-coat system	0.60 kg/liters or 5.0 lbs/gal
Three or four stage topcoat system	0.63 kg/liters or 5.2 lbs/gal
Specialty coatings	0.84 kg/liters or 7.0 lbs/gal

Corneel has been subject to these RACT Emission Limits since 1997, and has worked tirelessly to minimize the VOC content of his coatings. For example, in 1997, Corneel's motor vehicle refinishing operation used coatings with VOC contents below the levels required by RACT.[34] The volume applied and VOC content of the coatings Corneel used in 1997 are displayed in Table 19.

Table 19 -Corneel's 1997 Coating VOC Content Compared to RACT Limit

Coating Category	Volume Applied (gallons)	Corneel's VOC Content (lbs/gal)	Maximum Coating VOC Content Allowed (lbs/gal)	Difference (lbs/gal)
Pretreatment coat	3000	5.5	6.5	1
Precoat	3000	4.5	5.5	1
Primer/primer surface	3000	4.5	4.8	0.3
Primer sealer	3000	4.5	4.6	0.1
Topcoat or base-coat/ clear-coat system	5000	4.0	5.0	1

32 Some phases of the refinishing process require quicker drying coatings than others, so the VOC limits will vary depending upon the application. High VOC usually means quicker drying.

33 The VOC content of the coatings Corneel (and hopefully everybody else) uses is available from the manufacturer and/or supplier of the coating. If this information is not available through the supplier directly, the Wisconsin Department of Commerce Small Business Clean Air Assistance Program describes the calculation in detail in their pamphlet entitled Clean Air Facts: Motor Vehicle Refinishing RACT. This informational booklet is available at ftp://www.commerce.state.wi.us/MT-CA-MotorVehRACT.pdf.

34 Corneel uses a base coat/clear coat painting system in his refinishing process.

Once Corneel understands the RACT emission limits and how the VOC content of his coatings are well below those limits, he can estimate VOC emission reductions for each year from 1997 to 2002. In order to do this, Corneel must know the volume of coating used each year for each process. Fortunately, the Motor Vehicle Refinishing RACT requires excellent record keeping, and the data were not hard to obtain. 1997 data, which are included in Table 19, above, will be used to illustrate the process Corneel must follow.

Corneel knows the VOC content for each coating process for 1997, and can compare his low-VOC coating with the RACT requirement. The difference between the VOC content of his coating and the RACT VOC limits in pounds of VOC per gallon are multiplied by the total gallons of coating applied to determine VOC emission reductions, as illustrated by the equation below.

(RACT limit – Corneel VOC content) * volume applied = VOC emission reduction.

The results of these calculations for Corneel's coating processes in 1997 are given in Table 20.

Table 20 -Corneel's VOC Emission Reductions for 1997

Coating Category	Difference (lbs/gal)	Volume Coating Applied (gallons)	Emission Reduction (lbs)	Emission Reduction (tons)
Pretreatment coat	1	3000	3000	1.5
Precoat	1	3000	3000	1.5
Primer/primer surface	0.3	3000	900	0.45
Primer sealer	0.1	3000	300	0.15
Topcoat or base-coat/ clear-coat system	1	5000	5000	2.5
Total		**17,000**	**14,200**	**6.1**

Corneel can register emission reductions of 6.1 tons of VOCs and is now ready to fill out the RIF and PIF forms for his auto painting facility. Even if Corneel's permit was changed to reflect the lower emission rates, the emission reduction is still considered to be voluntary and can be registered because the emissions are below those required by the RACT rules.

Table 20 displays Corneel's emission reductions for 1997. Similar calculations would have to be completed to determine emission reductions for subsequent years, and may differ depending upon VOC coating content and volume applied.

Since his operation is located in the southeastern Wisconsin ozone non-attainment area, Corneel may register a portion of his emissions during the five-month ozone season [see NR 437.04(6)(3)]. For example, if we assume that 50% of Corneel's business occurs during the ozone season, then he could register half of his emissions (3 tons) as ozone precursors during the ozone season. This reduction must be reported as pounds or tons per day averaged over the five-month period. For Corneel this would be:

(3 tons * 2000 lbs/ton) / 153 days = 39 lbs per day emitted during the ozone season

This reduction of 39 lbs per day could possibly be sold as an offset in the ozone non-attainment area, assuming it is certified and meets all of the necessary legal requirements.

Example 12 - Renewable Energy

Barry is an executive at a progressive Wisconsin energy company called Bucky's Renewable Advanced Transmission System, or BRATS, whose vision of the future includes utilization of renewable energy resources. At Barry's urging, BRATS decides to develop a wind farm in the rolling hills outside of the city of Fond du Lac. BRATS owns the land, and some University of Wisconsin graduate students ran tests using available meteorological data to determine that wind quality (strength and duration) was adequate to support wind power on the site. BRATS installed twenty-five 400 kW wind turbines on the land. The wind farm became operational in 2001. Barry wants to register BRATS' emission reductions with the Wisconsin Voluntary Emission Reduction Registry.

Dave, one of BRATS many environmental engineers, monitors how often the turbines run. Dave learns that, over the course of the year, they run an average of 40 percent of the time. This means the wind turbines have a capacity factor of 40 percent.[35] Based on Dave's expert analysis, Barry calculates that the turbines produced 35,040 MWh of electricity using the method presented in Table 21.

Table 21 - BRATS 2001 Annual Wind Farm Electricity Generation

# Turbines	Capacity per Turbine	Total Annual Capacity	Total 2001 Annual Electricity Production	Total 2001 Annual Electricity Production
		(400 kW * 25 * 8760 hours)	(87,600,000 kW * .40)	(35,040,000 kWh / 1000)
25	400 kW	87,600,000 kWh	35,040,000 kWh	35,040 MWh

The energy produced by the wind turbines offsets emissions from less environmentally friendly types of electricity generation. To determine the amount of pollution offset, it is necessary to have electricity grid emission factors that represent the average fuel mix used to generate power in the given region (coal, natural gas, hydro, wind, solar, geothermal, etc.). Barry uses Wisconsin average emission rates gathered from the USEPA's Emissions & Generation Resource Integrated Database (EGRID).[36] The average emission rates for the Wisconsin are given in Table 22.

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35 To keep this example simple, we will assume that when the turbines operate (ie. 40% of the time), they operate at maximum capacity. So, during the 40% of the time that the turbines spin, each one operates at the full capacity of 400 kW. This won't be the case in reality, and depends on the quality of wind present at the time of generation. For simplicity, we will also ignore transmission and maintenance energy losses. These could be significant as well.

36 EGRID Emission factors are available at: http://www.epa.gov/airmarkets/egrid/index.html, and are comprised of data on Wisconsin generating unit characteristics collected from a variety of federal sources.

Table 22 - EGRID Average Emission Rates for Wisconsin Electricity Generating Units

Pollutant	Emission factor
NOx	4.2 lbs/MWH
SO2	8.2 lbs/MWH
CO2	1851 lbs/MWH
Mercury	0.034 lbs/GWH

Barry can use these average grid emission factors to determine the amount of pollution that would have occurred had the power generated by the wind turbines been generated using the average fuel mix for the state of Wisconsin (primarily coal). Barry multiplies the total MWh of electricity produced by the wind farm by each emission factor to determine avoided emissions. To calculate mercury emissions, he must convert the total energy to GWH by multiplying by 0.001. He then divides the pounds of emission by 2000 to determine how many tons are reduced (except for the mercury emissions, which are too small to convert to tons). The emission reductions are given in Table 23.

Table 23 - BRATS 2001 Wind Farm Emission Reductions

Pollutant	Emissions Reduced (lbs)	Emissions reduced (tons, except Hg)
NOx	147,168	73.6
SO2	287,328	143.7
CO2	64,859,040	32,430
Mercury	1.19	1.19 pounds

All of BRATS' emission reductions are over the registration thresholds listed in Table 1 in the registry rule (NR 437), so Barry can register all of the emission reductions. He can register them all even if only one of them is over the registration threshold [see NR 437.03(5)(c)]. Barry can now fill out RIF and PIF forms for BRATS.

Appendix C - Global Warming Potentials and Atmospheric Lifetimes

Gas	**GWP** [a]	**Atmospheric Lifetime** (years)
Carbon dioxide (CO_2)	1	50-200
Methane (CH_4)[b]	23	12.3
Nitrous Oxide (N_2O)	296	120
HFC-23	12,000	264
HFC-32	550	5.6
HFC-125	3,400	32.6
HFC-134a	1,300	14.6
HFC-143a	4,300	48.3
HFC-152a	120	1.5
HFC-227ea	3,500	36.5
HFC-236fa	9,400	209
HFC-4310mee	1,500	17.1
CF_4	5,700	50,000
C_2F_6	11,900	10,000
C_4F_{10}	8,600	2,600
C_6F_{14}	9,000	3,200
SF_6	22,200	3,200

Source: IPCC 2001

[a] 100 year time horizon

[b] The methane GWP includes the direct effects and those indirect effects due to the production of tropospheric ozone and stratospheric water vapor. The indirect effect due to the production of CO2 is not included

Appendix D - Emission Reduction Registry Rule

http://www.legis.state.wi.us/rsb/code/nr/nr437.pdf

Appendix E – Application Forms

Registrant Information Form

http://www.dnr.state.wi.us/org/aw/air/registry/pubs/4500176.pdf

The Project Information Form

http://www.dnr.state.wi.us/org/aw/air/registry/pubs/4500175.pdf

Appendix F – Application Form Instructions

Registrant Information Form Instructions

http://www.dnr.state.wi.us/org/aw/air/registry/pubs/rif_instructions.pdf

Project Information Form Instructions

http://www.dnr.state.wi.us/org/aw/air/registry/pubs/pif_instructions.pdf

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